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The American Association of Genito-Urinary Surgeons

First Day, May 6th, 1913

INCRUSTATIONS OF THE RENAL PELVIS AND URETER

By John R. Caulk, A. M., M. D., of St. Louis, Mo.

SINCE reporting to this Association last year a case of calcareous incrustation around one of the renal papillæ, I have encountered three cases presenting a somewhat similar pathological process, which I desire to present for your consideration.

The whole question of stone formation and of calcareous deposition in the genito-urinary tract, as well as in the body tissues in general, is surrounded by such an atmosphere of confusion, that much attention and interest have centered on it. Many hypotheses have been proposed and many debates created.

The pathological picture of the case above referred to, seemed to warrant the conclusion that the incrustation of the renal papilla was secondary to a papillary necrosis. In reviewing the opinions of other men on the subject of calcareous deposits in the body tissues, it is found that the great majority are of the opinion that necrosis is the prime factor in such formations.

Delafield and Prudden, in their chapter on "Calcareous Infiltration" say, that in this condition there is a deposition,

either in the cells or intercellular substance, of larger or smaller granules composed chiefly of phosphate or carbonate of calcium. Pathological calcification usually, if not always, occurs in parts which are dead or in a condition of reduced vitality as a result of antecedent abnormal processes which, as a rule, are of inflammatory nature. Fatty degeneration of the cells frequently precedes calcification.

Liek has found in his experiments that calcareous deposition in the kidney is markedly hastened by circulatory disturbances. Regarding circulatory disturbances Maschka says that heart disease can have an influence in the production of stone. Liek concludes that a combination of necrosis and circulatory embarrassment is necessary for calcareous deposits; while Aschoff lays stress especially on urinary stasis and the excessive secretion of certain salts.

Ebstein calls particular attention to the role played by colloids. In stone formation he believes that colloids form the ground substance which is absolutely essential, no matter what the composition of the stone. He was able to produce, in animals, renal, ureteral, and vesical calculi by feeding the animals on oxamid, which he believes acts as a toxic agent on the epithelium of the urinary tract, causing degenerative changes, and that the degenerated epithelial cells impregnated with oxamid form the nucleus of the stone.

Ehrlich considers the presence of iron in the tissues to have an important bearing on calcareous deposits.

Kumita believes that infection plays the important role in incrustation. This was contradicted by Tuffier.

Mueller says that, as a result of primary necrotic inflammation of the kidneys, salts are formed around the tissues which are injured, and incrustations and stone formations ensue.

Litten proved that hæmorrhagic infarcts and tissues with arterial anæmia possess a high affinity for calcium. Many authors believe in a specific diethesis. Some claim that patients suffering with gout, rickets, osteomalacia and spinal caries

have a special disposition to stone formation. This is greatly questioned by others.

Among the various diseases, which have been suggested as having an etiological influence in stone formation, have been typhoid fever, diphtheria, cholera, auto-intoxications, icterus, eclampsia, gout, and diabetes.

The poisons which may predispose to this disease are cantharides, corrosive sublimate, chromates, chlorates, oxalic acid, aloin, glycerin, phosphorus, arsenic and vinylamin. By chronic poisoning, with the latter, Levaditi was able to produce a papillary necrosis and secondary incrustation with salts.

Thus it seems that the majority of observers agree that the essential process for calcareous infiltration is necrosis.

The question next arises, Why are these salts deposited in areas of necrosis?

The rationale of the deposition of salts in the damaged cells and tissues is not clear, and much work is being centered on the problem. In infiltration in various tissues of the body, the salts are derived from the blood and lymph, but in the genito-urinary tract they are evidently derived from the urine which, it may be possible, is hypersaturated with them on account of a special diathesis.

The presence of phosphorus in the affected tissues, the existence of fatty acids with which the calcium may form insoluble soaps, and proteids capable of uniting with calcium, have all been advanced as determining factors. This whole question was admirably presented by Wells in his Harvy lecture.

The comparative rarity of primary incrustations in the upper urinary passages, seems to me to make the report of the following four cases not superfluous.

Case I. Obstructive Calcareous Papillitis. Retention Cyst of the Kidney. This case was reported in detail in the Transactions of this Association last year, and in this report the history will be given in abstract.

Patient, male, 46 years of age, farmer. Complained of dull

aching pain in the right side beneath ribs, occasional reflection along the ureter into the scrotum; also had symptoms referable to the posterior urethra and prostate.

Family history: Father died of cancer.

Personal history: There is nothing of importance in his personal history with the exception of typhoid fever at the age of twenty-one.

Present illness: His present trouble started about a year and a half ago with an acute colic in the right side below the costal margin, which radiated along the ureter into the scrotum. Since this time there have been many similar attacks. Coincident with this there was increased frequency and slowness of urination, slight hesitancy and diminished force of the stream, and hæmaturia. The attacks of pain above described were exceedingly severe in the beginning, but were quieted by local applications. He did not pass stone or gravel. The pain in the last attacks was not sharp, but of an aching, throbbing character. Upon examination it was found that the urinary distress was due to a subacute prostatitis and posterior urethral engorgement, which promptly cleared up on treatment of these organs. The throbbing pain in the right side, however, persisted. An X-ray picture at this time showed a small crescentic shadow in the region of the right renal pelvis. Ureter catheterization procured perfectly normal urine from both sides, with the exception of an occasional red blood cell from the right. Phthalein test appeared on the right side in nine minutes; on the left in eight minutes. First hour output on the right side 15 per cent.; second hour, 12 per cent. First hour on the left side 18 per cent.; second hour, 13 per cent. On the presence of the shadow and the finding of a few blood cells from the centrifugalized urine, a lumbar nephrectomy was done, and the following interesting pathological picture was obtained. A cyst, the size of a small walnut, was found in the lower pole of the kidney, corresponding to one of the pyramids, the papilla of which was incrusted with a calcareous material, which later was found to be composed principally of

calcium phosphate. As this paper has its bearing only on incrustations, a description of the cyst and of the kidney in general will be omitted.

A pathological report of the papillary lesion given by Dr. Opie is as follows: The sections were preserved in 4 per cent. formalin, and the material was decalcified with 5 per cent. nitric acid. Blocks were mounted in paraffin and stained with hematoxylin and eosin. The section of the papilla with the incrustation showed that the tip of the papilla was covered with a homogeneous material, which took a deep blue stain of decalcified material. The tissue of the papilla was dense and fibrous and contained very few cells. The tissue in immediate contact with this mass has undergone hyaline degeneration. In this hyaline area, as the calcified mass is approached, numerous minute calcified granules are seen. Deeper into the substance of the papilla, the tissue is loose in texture and contains numerous blood-vessels. There are also occasional collections of lymphoid cells. It was thought that this condition was due to a primary necrosis of the papilla with a secondary deposition of calcium phosphate.

Case II. Incrustation of Calcium Phosphate on the Posterior Wall of the Renal Pelvis.

Patient 35 years of age, male. Complained of aching pain in the right kidney region and blood in his urine.

Family history: Negative.

Personal history: The only diseases of importance were diphtheria at the age of 18, and acute tonsillitis in 1909. Following this the patient began to suffer with pain in the right kidney region and occasionally with pain in the right side lower down, for which he sought relief in the hands of a Chicago surgeon who removed his appendix, which was said to be gangrenous. Shortly after this, he had another similar attack, and since then has had attacks with much greater frequency. In October, 1910, during the course of one of these attacks he passed blood in his urine. Since then he has passed

blood with most of the attacks of pain. I saw him in November, about one week after one of his sieges.

Examination: Patient was a slender, anæmic individual, but nothing abnormal was found in his general physical examination.

Cystoscopic examination: Catheter passed easily. No residual urine. Bladder capacity normal, both ureteral orifices normal in appearance. Ureteral catheters passed easily on both sides and the urine showed the following: Right side, many white blood cells, few red blood cells, and colon bacilli, albumin, no casts. Left side, clear, no albumin, few red blood cells. Phenolsulphonephthalein, given subcutaneously in a 6 mg. dose, appeared on the right side in 12 minutes. First hour output, right side 32 per cent. Left side appeared in 12 minutes, first hour output 35 per cent. X-ray picture showed a shadow in the region of the right kidney pelvis. Right lumbar nephrotomy. Kidney was freed and delivered and bisected with silver wire. No stone was found in the kidney. By invaginating the renal pelvis it was found that a brownish incrustation lined the greater part of the posterior wall. A sponge was packed below and this calcareous material shelled off from the wall of the pelvis to which it was very adherent, and in one place the pelvic wall was torn during the removal of the material. The tissue under the calcareous material was very granular and friable. After the incrustation was completely removed, the pelvis was thoroughly irrigated. Kidney closed in usual manner. Small drain to kidney. Wound closed with interrupted catgut. Following operation there was a slight urinary leakage for three days. This promptly ceased, and the patient made an uninterrupted recovery. Since then he has been perfectly free from pain, has gained weight, and urine is perfectly clear.

Whether the necrotic pelvic wall was secondary to the calcareous deposit, or whether the changes in the pelvic wall were primary and responsible for the deposit, cannot be definitely stated; but from the pathological findings of other ob-

servers it would seem that the calcareous deposition was secondary to the changes in the renal pelvis, similar to what was found in the papilla in Case I.

Case III. Incrustation of the Upper Ureter.

Patient, a woman, 32 years of age, whose complaint was intermittent attacks of colicky pain in the epigastrium and an occasional soreness in right upper back.

Family history: Negative.

Personal history: No acute illness, no chronic cardiac, pulmonary or gastro-intestinal disorders. Menstrual history normal. Has borne two children, both deliveries normal. There was never any trouble during her pregnancies.

Present illness: Two months after first child was born, that is eight years ago, she was suddenly seized with cramps in her epigastric region which lasted for several hours. Pain did not radiate, and as she described it, "stayed in the pit of her stomach." Since that time she has scarcely passed a day without having a similar pain. These attacks have borne no relation to food or to constipation. Has never had any chills, fever, sweats, or jaundice. There has been absolutely no urinary frequency, pain or hæmaturia. Two years ago she had her appendix removed for the trouble, but without relief. Since that time she has been observed by numerous men who have presented various diagnoses. Among the diagnoses may be mentioned, gallstones, cholecystitis, gastric and duodenal ulcer, pyloric spasm, pelvic inflammatory disease, and others. During this time she had about thirty X-ray pictures and fluorescopic examinations with bismuth meals. Her husband, who is a friend of mine, desired that I determine the condition of her kidneys. On inquiring into her case, I found that she had absolutely no symptoms referable to her kidney regions with the exception of an occasional ache in right upper back. She had never passed any stone or "gravel," to her knowledge.

Examination: In spite of all the trouble and suffering, she was very well preserved. There was nothing found in the

general abdominal examination. No tenderness anywhere in the abdomen. Urine perfectly clear, but on centrifugalization an occasional white blood cell and some calcium oxalate crystals were found. No trace of albumin. Cystoscopic examination showed a perfectly normal bladder. The right ureteral orifice was slightly larger than the left, but presented no evidences of an inflammatory reaction. Left catheter passed easily to the renal pelvis. Right catheter was obstructed three inches lower than the left. Urine from the left side negative. From the right side occasional white blood cells and many calcium oxalate crystals. As I thought it possible that her condition might be due to an intermittent hydronephrosis, both pelves were injected with 10 per cent. collargol. The left pelvis was normal. On the right side, I was unable to get the collargol into the pelvis. Immediately after withdrawing the catheter, patient was seized with a pain similar to the ones above described, which lasted about two hours, and required morphia. Following this attack she voided urine which contained many particles similar to crushed egg shell, but of a yellowish brown color. Several days later an X-ray picture showed a faint shadow about one and a half inches long, evidently in the upper ureter. A shadowgraph catheter was passed and another picture taken. The catheter obstructed exactly at the lower margin of the shadow. At this time the catheter was manipulated freely; following which she passed a considerable amount of this granular material. Since this time she has never had an attack of pain, has gained a great deal of weight, and feels perfectly well. After the third treatment, catheter passed easily to the pelvis and an X-ray picture showed that a shadow was still present, but considerably smaller. Encouraged by the relief obtained by the ureter catheter, I attempted to remove this deposit by means of the catheter. After ten manipulations, extending over a period of three months, in which the patient has been perfectly free from pain, an X-ray picture shows no shadow. After each catheterization, I injected the upper ureter with 10 per cent.

argyrol. The functional test with phenolsulphonephthalein, given after the third manipulation, yielded the following: Time of appearance eight minutes on both sides. Right side, first hour, 19 per cent.; second hour, 10 per cent. Left side, first hour, 22 per cent.; second hour, 10 per cent.

A resumé of the important facts of this case is as follows: (a) Reflection of pain to the epigastrium with no radiation along ureter and no urinary distress; (b) marked amelioration after the second ureter catheterization; (c) numerous diagnoses of different abdominal conditions, and (d) the removal of the incrustation by means of the ureter catheter.

In the beginning, I was at a loss to know whether to advise operation with the removal of the calcareous deposit or to attempt the procedure which was finally adopted. It impressed me that having a normal kidney and a long incrustation in a narrow canal with evidently an inflammatory ureter back of it, the chances of subsequent stricture would be great, with a probability that a nephrectomy would have to be the final issue. Hence, it seemed, even if the incrustation could not be removed, if the patient could be relieved of pain and the ureter kept patent this would be the most desirable.

I solicit the opinion of this Association on this particular point.

Case IV. Male, 52 years of age, complained of an aching pain in right side beneath costal margin.

Family history: Negative.

Personal history: Gonorrhœa as a young man, no complications. Typhoid fever in early adult life, otherwise negative.

Present illness: Five years ago patient had an attack of colic in his right side radiating into the scrotum and penis, associated with urinary frequency and pain, followed by the passage of a small irregular calculus. Since that time, he has had three similar attacks, each time passing a small jagged stone. General health has been good since last attack. No

chills, fever, or sweats, and no urinary distress. Three days before I saw patient he began to complain of an aching pain in right side beneath ribs with the feeling, "as though his side was being blown out." There had been marked diminution of urinary secretion and for twenty-four hours patient had been nauseated, vomited, and suffered with headache; also slightly irrational. Temperature ranged from 100° to 101.5° F. During the previous twenty-four hours had voided but three ounces of urine.

Examination: A large man, flushed, slightly irrational, marked tenderness in right kidney region with kidney considerably enlarged.

Cystoscopic examination: Catheter passed easily, two ounces of very concentrated urine withdrawn. Bladder capacity normal. The left ureteral orifice normal in appearance; right ureteral orifice œdematous and pouting. Ureter catheter passed easily on left side, but, on the right side, obstructed one-half inch within the orifice. With the catheter in place, sterile water was injected into the ureter for the purpose of washing out some of the contents. The urine from the left side was clear and contained no pus cells or bacteria, but many hyaline casts and calcium oxalate crystals. No urine could be collected from the right side. Patient was put on rectal salt solution, purged and given large quantities of water to drink. X-ray picture showed a very faint shadow about three-fourths of an inch long low down in the ureter, corresponding to the location in which catheter obstructed. The following day, a shadowgraph catheter was passed into the orifice, and after much manipulation passed by the obstruction. Large quantities of urine drained through the catheter and patient was relieved of his pain. The urine was loaded with calcium oxalate crystals. After the kidney was drained thoroughly, catheter was again moved to and fro in the lower ureter, and argyrol injected. Two days later a similar procedure was undertaken. The material which passed

was not only sandy, but there were many long, flat spicules, similar to Case III. This patient was advised to keep himself under close observation and to have the catheter passed at frequent intervals; however, he failed to take the advice given and I have not seen him since last August, but he writes me that he is feeling perfectly well and has no trouble.

It is to be observed that the incrustations in the cases above reported occurred in different parts of the upper urinary tract, establishing no special point of predilection. Two of the cases exhibited a definite pathological background for the calcareous deposit; an inflammatory lesion of the renal pelvis in one case, and of the papilla in the other. In the ureteral cases not coming to operation, the fundamental lesion could not be determined; but in the light of the other two cases, it is safe to assume that such a lesion was present in these also, and served as the etiological factor for the calcareous implantation. In the two cases in which the incrustations were examined chemically, it was found that they were composed of calcium phosphate with traces of calcium oxalate. In the two ureteral cases, I was unfortunate in not securing enough of the material for chemical analysis. In Case III, through a mistake, the nurse did not save the total urine as I had directed, and in Case IV, I forgot to leave instructions for the urine to be saved and strained. However, the urine in these two cases contained calcium oxalate crystals and the dry material presented the gross appearance, similar to the other cases. Thus it seems evident that the deposit in all four cases consisted of calcium. As possible etiological contributors for the incrustation in the four cases, typhoid fever in two cases, diphtheria in two cases, tonsillitis in one case, may be mentioned. In the last mentioned case, immediately following the attack of tonsillitis, the first renal storm was ushered in. It seems highly probable that there had been an acute pyelitis.

Case IV, (incrustation of the juxtavesical ureter) had passed previous calculi which must undoubtedly have caused

inflammatory changes and necrosis of the lower ureter. Case III, (upper ureteral incrustation) presents a negative history as to the passage of calculi. It is possible, however, that in her initial attacks calculi may have passed, which produced changes in the upper ureter and afforded a nidus for calcareous implantation. On the other hand, it may be that there had been a local circulatory disturbance. Three of the cases were males and one female. The symptomatology of three of the cases suggested a kidney lesion and presented nothing noteworthy. Case III (upper ureteral incrustation), presents an interesting feature, in that there were practically no symptoms referable to the kidney with the exception of a very occasional soreness in the right back. The reflection of the acute pain to the epigastric region, occurring in paroxysms of great frequency, which suggested to many able clinicians and surgeons some intraperitoneal lesion, is noteworthy. It is possible that many of the gastric and duodenal ulcers and gallstone colics may have their origin in lesions in the upper ureter associated with an intermittent hydronephrosis.

Concerning the diagnosis of these incrustations, each of the cases within the pelvis was diagnosed as renal calculus, and the true diagnosis was established only at operation. The two ureter cases were diagnosed as incrustations based on the following facts: (a) faint X-ray shadow similar to Cases I and II; (b) the passage of crushed egg shell like material following manipulation with the ureter catheter; (c) the passage of the catheter through the obstruction, relieving the patient of symptoms, the X-ray shadow still persisting; and finally the gradual disapperaance of the shadow, as in Case III, by manipulation with the ureter catheter. These points seem to differentiate a true incrustation from a calculus or a sandy impaction.

The treatment of such cases depends upon their location. Incrustations around the papillæ or in the renal pelvis should be removed by nephrotomy, provided they are productive of

symptoms which demand operative intervention. The ureteropelvic juncture should be blocked to prevent any particles from getting into the ureter. After the removal of the incrustation the pelvis should be thoroughly lavaged. Post-operative treatment is similar to that of an ordinary stone case, with the exception that the pelvis should be injected with argyrol several times during the first few months. Pyelotomy seems unadvisable in such cases, as it will not provide sufficient exposure to insure the complete removal of the calcareous material. With incrustations in the ureter, our object is to do as little damage as is possible to the ureter in attempting their removal, so as to lessen the liability to post-operative stricture. In the removal of an ordinary calculus the calculus can either be milked back into the dilated part of the ureter and thence removed through a small incision, or it can be removed *in loco* through a small incision, being extracted endwise; whereas with incrustations these procedures cannot be adopted.

There are three methods which may be utilized for the removal of these incrustations.

First, opening the ureter throughout the length of the deposit and shelling off completely all of the incrustation under the guidance of the eye.

Second, making a small incision in the ureter above the incrustation and by means of a small blunt curette, which is introduced into the ureter, removing the calcareous material.

Third, removal by means of the ureter catheter.

With the first procedure, I am inclined to think that the chances of subsequent stricture would be extremely grave. The second procedure does not seem justifiable until an attempt has been made to remove the incrustation by means of the ureter catheter, which seems to me to be the method of choice, at least it should be given a trial before more radical measures are attempted. I see only one criticism that could be offered to the initial trial with the ureter catheter and that is the remote chance of puncturing the ureteral wall and hav-

ing as a complication, urinary extravasation. This complication should rarely occur with one who is skilled in the manipulation of the ureter catheter.

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MALIGNANT PAPILLOMA OF THE PELVIS OF THE KIDNEY WITH TRANSPLANTATION IN THE BLADDER

By William E. Lower, M. D., of Cleveland, Ohio

PRIMARY tumors of the renal pelvis are very rare. Watson and Cunningham[1] report that Israel found only two cases of kidney pelvis tumors as compared with 68 in the kidney parenchyma, and that there was but one tumor (a papilloma) in 94 cases of renal and perirenal growths recorded at the Massachusetts General and Boston City Hospitals in 10 years. In 1904 Albarran and Imbert in their book "Traité des Tumeurs du Rein" found only six instances in all of the literature on the subject. Stüsser[2] in 1912 reported a considerable number of tumors of the renal pelvis and a small number in which the ureter and bladder were also involved.

To the small number of recorded cases in which there was transplantation into the bladder I desire to add another which came under my observation within the last year.

An unmarried woman, 63 years of age, was referred to me by her family physician, Dr. I. J. Wright, on August 5th, 1912, because of her hæmaturia.

Family history: Father died at the age of 84, mother at age of 83. The family history was negative for cancer, tuberculosis and goitre.

Personal history: She has had the usual diseases of childhood. Scarlet fever at age of 6. Never had typhoid fever or pneumonia. General health has been good until within the last three or four years. She has had no cough, generally a good appetite. Has had two gastro-intestinal upsets. Menses began at age of 11, have always been regular and not painful. Menopause at age of 53. Has had no vaginal hæmorrhage since. Five years ago patient strained her back in lifting. Following this she had considerable pain and soreness in back, which gradually wore off.

Present illness: For the past three years patient has passed bloody urine at various times. The first time she noticed the bleeding was after an acute retention caused by a large blood clot which obstructed the urethra. She has lost considerable blood in the past three years. Has had some dull pain in the back. It was perhaps more noticeable in the region of the left kidney. At the time of her reporting she was quite pale and weak.

Physical examination: Showed a well nourished person with rather white skin, mucous membrane pale, but free from scars, eruptions or pigmentations. Vision was poor in the left eye, pupils were equal and regular and reacted to light and color. Some slight enlargement of the submaxillary and submental glands. No tumors palpable in the breasts. Lungs were resonant throughout and showed good excursions at the bases. Precordial area did not bulge and no thrills or friction rubs palpable. Heart about normal in size and the sounds were distinct; no murmurs discernible. Pulse was regular, rhythmic and of good volume; 90 per minute. No apparent enlargement of the liver. Both kidneys were palpable and the left somewhat tender. Extremities were symmetrical and reflexes active.

Cystoscopic examination: Bladder capacity 150 c. c. Introduction of the cystoscope easy. Situated just to the left of the left ureteral orifice was a dark tumor mass about the size of a hickory nut. Upon closer inspection this was apparently an organized blood clot. It was adherent to the mucous membrane and could not be detached by the beak of the cystoscope.

After observing the rest of the bladder, which was found free from growth, stone or ulcer, and then reinspecting the tumor a small amount of blood was seen upon the mucous membrane in that locality. My first impression was that the bleeding came from the base of this clot, but after a little longer inspection blood was seen to be spurting at irregular intervals from the left ureteral orifice. The urine from the right ureter was clear. The diagnosis of left renal hæmaturia

PLATE I.—Presented by Dr. W. E. Lower

Fig. 1

Growth in bladder, removed at the time of first operation.

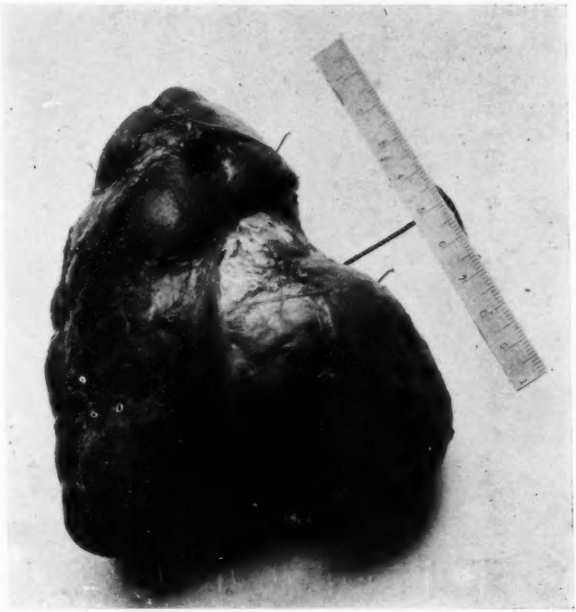

Fig. 2

Photograph of kidney showing distended pelvis.

was established but the exact cause undetermined. An exploratory operation was advised but declined at this time. As there was a possibility of this being a so-called essential hæmaturia injections of blood serum were recommended. The patient returned to her home and I heard nothing more from the case until October 19th, when she returned, stating that she had been bleeding more or less continuously since her previous visit. She had had several injections of the serum without any definite benefit. Had lost considerable in weight and seemed paler and much more feeble than at the previous examination.

She was sent to Lakeside Hospital and on October 21st another cystoscopic examination was made.

Cystoscopic examination No. 2: At this time the bladder capacity was 300 c. c. Introduction of the cystoscope easy. The dark tumor which had been observed at the previous examination was still present and it was plainly to be seen that this blood clot was adherent to a growth, only a small part of which was visible beneath the clot. In addition to this tumor which had been observed at the previous examination there was another growth about one-half the size of the larger tumor, situated upon the other side of the left ureteral orifice about one-quarter of an inch from the opening, as shown in Plate I, Fig. 1. This was papillomatous in appearance, and was not bleeding. The ureters were catheterized, urine flowed freely from the right side, but only a small amount of turbid urine was obtained from the left side. Phthalein intravenously appeared on the left side in three minutes and at the end of fifteen minutes 25 per cent. was recoverel. At this time there was no discernible bleeding from the ureter nor from either tumor. X-ray pictures of the kidneys and ureters were negative.

From the history of the case and from the previous examinations there seemed to be evidence enough to warrant an exploratory operation on the left kidney before undertaking to remove the tumors from the bladder, although there re-

mained some doubt as to whether or not I might have been mistaken in the source of the bleeding. The tumors in the bladder were sufficient cause for the hæmaturia and yet the length of time that the patient had observed blood in the urine, the slight tenderness in the region of the left kidney and the appearance of a second tumor since the first examination, led us to speculate on the possibility of a tumor of the renal pelvis with transplantation into the bladder.

Operation: As she had stopped bleeding the operation was delayed for a number of days, hoping that she might gain some strength and be a better operative risk. Her hæmoglobin at this time was 60. On October 26th, under gas anæsthesia, with local infiltration of novocaine, the usual oblique incision was made for the exposure of the kidney. The kidney was found to be somewhat enlarged and the pelvis very much distended. (Plate I, Fig. 2.) Palpation did not reveal any concretions or solid tumor but a doughy mass could be detected. We did not consider it advisable to open the kidney pelvis lest we might infect the wound with the contents. The kidney was removed and the ureter ligated at a point about three inches from the kidney. At the point of division of the ureter there was no evidence of growth. The wound was closed with chromic catgut and the small cigarette drain inserted.

The patient was then placed upon her back and slightly in the Trendelenberg position. A transverse incision was made above the pubis, the recti muscles separated, the bladder exposed and opened. The tumor containing the organized blood clot, at the base of which was a papillomatous growth, was removed; it was about the size of a filbert. The point of excision sutured with 00 chromic catgut.

The other tumor was much smaller and much softer. It was removed in a similar manner and the wound closed. No other evidence of tumor was found anywhere in the bladder. The opening into the bladder completely closed without drainage. The patient stood the operation well and there was no change in the pulse rate.

PLATE II.—Presented by Dr. W. E. Lower

Fig. 1

Growth in bladder, removed at the time of second operation.

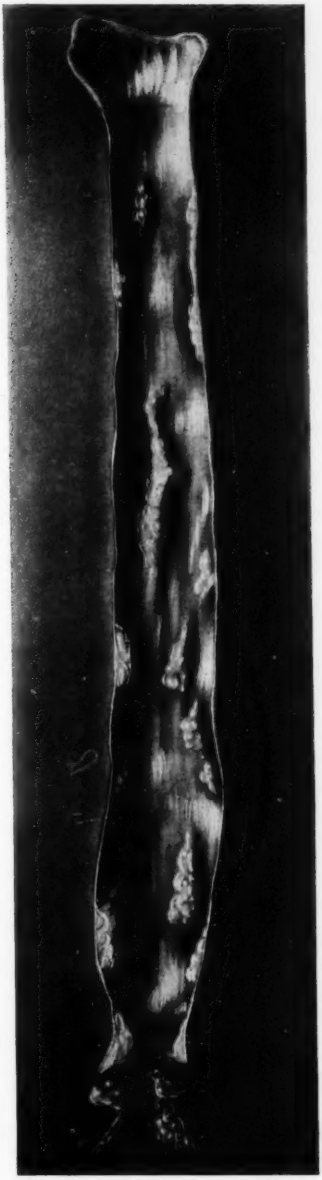

Fig. 2

Papillomatous growth in ureter and left ureteral orifice.

Post-operative history: On October 28th, the wound was inspected and the drain removed from the kidney wound. It was clean and apparently healed by first intention. Patient was comfortable and voiding easily. The urine was bloody. On the 30th the clips holding the skin were removed. Patient was still passing bloody urine. This was difficult to account for but thought to be due to bleeding from the bases of the tumors which had been removed from the bladder. On October 31st urine was still bloody. Bladder washed with boracic acid and adrenalin solution injected. November 2d hæmorrhage from the bladder very slight, general condition of the patient good. She was discharged November 23d in very good condition and feeling very comfortable. On January 21st, 1913, patient telephoned me from her home in a near-by city that she was again having hæmorrhage from the bladder. She reported at the office on the 22d. She had gained considerably in weight, her color was much improved, and she stated she felt better than she had for a number of years.

Cystoscopic examination No. 3: Bladder capacity 150 c. c. Extending from the left ureter and folding back on each side was a growth. (Plate II, Fig. 1.) It was evident that this growth came from within the ureter and seemed to be pushing down and out of the ureteral opening as shown in the cut. It was quite apparent that the ureter was involved and a second operation advised for its removal. She returned to the hospital and on January 28th, 1913, was again operated upon under nitrous oxide anæsthesia and novocaine infiltration.

Incision was made extending from the lower end of the old scar through which the nephrectomy had been done, uniting with the scar for removal of the bladder tumors. The ureter was dissected from the scar above and completely isolated to the entrance into the bladder and a part of the bladder excised, as shown in the cut (Plate II, Fig. 2). Bladder was closed and a small drain inserted down to the point of excision of the growth in the bladder. In removing the part of the

bladder around the ureteral orifice the peritonæum was opened accidentally and immediately closed with plain cat gut.

Cystoscopic examination No. 4, Feb. 14th, 1913: Bladder capacity 300 c. c. Around the region of the former ureteral orifice was a small mass of scar tissue and some inflammatory tissue. At the bottom of the bladder were a few small hæmorrhagic spots, otherwise the bladder mucosa seemed perfectly normal. Upon vaginal examination a small mass could be palpated in the region from which the left ureter had been removed. The mass was slightly tender and seemed to be inflammatory rather than a recurrence.

Cystoscopic examination No. 5, March 6th, 1913: Bladder capacity 300 c. c. In the region of the former ureteral orifice there was only a contracted scar, the œdema which had been present at the previous examination had entirely disappeared, but there still remained a number of the small hæmorrhagic spots. The exact nature of these could not be definitely determined, but there was a strong suspicion that they might be the beginning of a recurrence.

Cystoscopic examination No. 6, April 1st, 1913: At this time the bladder held 150 c. c. and situated just behind the trigonum near the area of excision of the left ureteral orifice was a small tumor mass. This was fulgurized on April 2d and again on April 8th and 19th. At this time the bladder seemed to be in a nearly normal condition, with almost entire disappearance of the tumor, there remaining only a white slough at the site of the growth. The pathologic report of the growth in the kidney, pelvis and ureter was identical, all three being malignant papilloma as shown in Plate III.

At this writing there is no evidence of recurrence of the growth in the region of the kidney or ureter. I am inclined to believe that the tumor at no time had gotten outside of the mucosa.

Upon opening the kidney pelvis it was found to contain considerable amount of broken down material with fringed edges along the calices, as shown in shaded part in dia-

PLATE III.—Presented by Dr. W. E. Lower

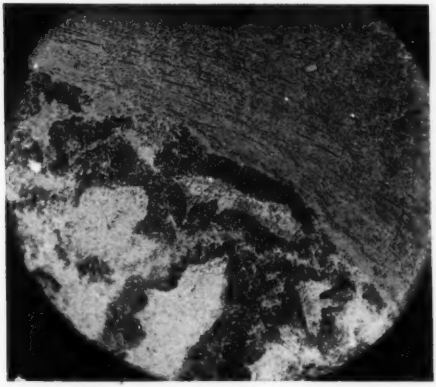

Fig. 1 Section through kidney.

Fig. 2. Section through ureter.

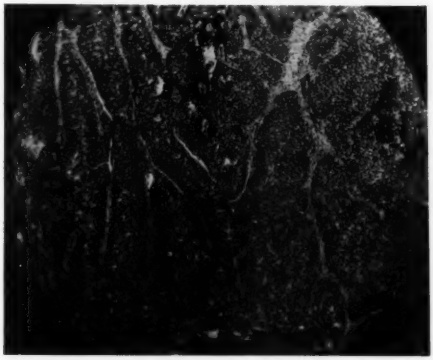

Fig. 3 Section through tumor of bladder.

PLATE IV.—Presented by Dr. W. E. Lower

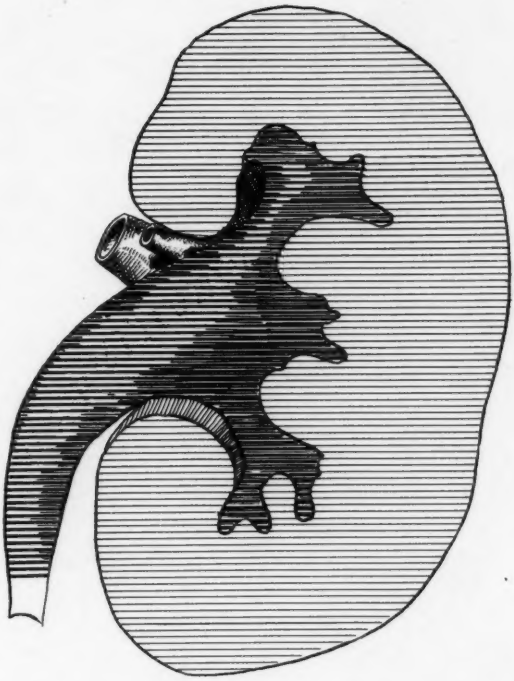

Diagram showing growth of the pelvis.

gramatic cut (Plate IV). The ureter, as has been noted in the cut, contained a number of patches of the growth, but greater in abundance near the lower end of the ureter where they seemed to pile up at the constriction of the ureter into the bladder.

Microscopic section of the ureter at the point of excision of the kidney was free from any evidence of growth.

No definite theory is advanced for the cause of these tumors. Albarran and Imbert[3] found that in 15 per cent. of their cases calculi were present and concluded that they had produced chronic irritation and thus furnished a good field for the neoplasms. They usually occur between the ages of 40 and 60 years and are more frequently found in men.

As for symptoms, they are quite variable and depend as a rule upon the stage of development. Hæmorrhage, tumor, pain and tissue elements in the urine generally indicate that a growth is present. The first sign is usually hæmorrhage. It may be continuous, intermittent and occasionally cases are noted in which it is absent entirely. It may also vary in amount, at times being scarcely noticeable and then again so profuse as to cause death. Cumston[4] noted that in cases of intermittent hæmatonephrosis one could usually suspect tumors of the renal pelvis. He also observed that when there is hæmaturia without retention it points as a rule to a growth in the upper part of the renal pelvis or calices and large hæmatonephroses usually indicate neoplasms in the renal pelvis close to the ureteral orifice.

Pain is not a constant symptom nor an important one. It may come in attacks of colic, unexpectedly and occasionally there is merely a sensation of numbness in either the opposite leg or in the loin and leg of the same side. Hartmann[5] reports a case of a man 51 years old who had suffered almost continuously with renal pain since his twentieth year. Another instance of long renal colic duration is Oraison's[6] case. It concerns a woman 50 years old (at the time of report), who complained of violent renal colic from her twenty-second to

her fortieth years. The pain occurred at intervals of one to three days and as a rule was followed by hæmaturia lasting several days. After she was forty the pains were less severe but continuous.

There are also some general symptoms to be noted, such as weakness, marked pallor, loss of flesh, anæmia, and loss of appetite. Fenwick[7] has called attention to an important sign, namely, that when there is a growth in the renal pelvis of the kidney in which there is pelvic dilatation the ureteral orifice is altered in the nature of a dull colored swelling and elongation of the opening of the ureteral orifice. This was not noted in my case.

It is very often hard to determine just where the growth is located but with the aid of the cystoscope and by ureteral catheterization and injection of collargol one may make a fairly accurate diagnosis. A tumor of the bladder at the ureteral orifice should lead one to suspect a growth higher up. It is not unlikely that in the recurrent tumors of the bladder especially those situated in proximity to a ureteral orifice the real source of the trouble is a growth in the ureter or kidney pelvis and the recurrences are transplants. Evidences of renal pelvis papilloma may be present for a long time, even months or years in a benign form and the general health may suffer only slightly. Sooner or later, however, it will show symptoms of malignancy. Early removal of kidney and I believe in most cases the ureter as well, is the only treatment.

Herewith are appended eighteen cases in which the ureter and bladder are involved. Case XVII reported by Picot is of striking similarity to my own.

Reports of Cases

Case I. Busse's[8] case in a man, age 43, who had a sudden attack of hæmaturia and pain in the left renal region. In the following seven years they did not entirely disappear. In his fiftieth year bladder hæmorrhages brought him to the hospital.

Nephrectomy was performed by Prof. Schuchardt. The patient recovered but died of exhaustion four and a half months after the operation. The inner surface of the renal pelvis was covered with fine villi, which reached to the ureter. There was a tumor in the bladder. The edge was covered with numerous long villi. At first these were benign, but a few months before death became malignant.

Case II. Kohlhardt's[9] case of a woman, 69 years old. For two years she had noticed blood in the urine intermittently. The left kidney was extirpated and a villous tumor was found partly reaching into the ureter. The renal pelvis and calices were much enlarged. In the upper half of the former close to the ureter end was a tumor mass (the size of a small pigeon egg) which inclined to the ureter. Small villous tumor masses were located on the entire mucous membrane of the renal pelvis and calices to the upper third of the ureter. Briefly stated, there was a multiple villous tumor formation originating in the left renal pelvis, renal calyx and ureter, the bases of which showed proliferation of the same. As a result of the villi the urine flow was hindered and hydronephrosis resulted. The patient was cured. Stüsser[10] in his account of the case, stated that Kohlhardt excluded carcinoma and inclined toward the diagnosis "Fibroma papillare diffusum" and "Pyelitis villosa" and also that the patient died of regionary metastases, a year and a half later.

Case III. Poll's[11] case of a man, 41 years old. Three and one-half cm. of the ureter was removed, also the left kidney. The renal pelvis was enlarged to the size of a man's fist. Small groups of gray-white protuberances were seen in the renal pelvis. He mentions the ureter growths first. Briefly stated, there was a villous tumor of the mucous membrane of the ureter and the renal pelvis of the left kidney, which did not penetrate deeply here, but did in the calices. He also had hæmorrhages. The growths extended toward the bladder. The specimens were examined after the death of the patient. Dr. Poll[12] says that years ago various names were used for these tumors,

such as: villous polypi, villous cancers, tumores villosi, fibroma papillare, papilloma without distinguishing between benign and malignant. Today they go under the name of villous cancer or carcinoma papilloma. Due to reasons unknown to him papillary growths existed on the mucous membrane of the renal pelvis and the ureter which showed plainly carcinomatous growths in the calices. It is not known positively whether they were benign or malignant at the start. It probably was carcinoma in the calyx.

Case IV. Rayer's[13] case of a woman, aged 58. She died of hæmorrhage. The autopsy showed a collection of fluid in the abdominal cavity. In the greatly enlarged liver were numberless cancer nodes of all sizes. The mesenteric glands were infiltrated with cancer. The kidney itself showed nothing. On the mucous membrane of the renal pelvis could be seen "small, pedicled tumors of gelatinous nature." Similar changes are also found in the ureter and bladder.

Case V. Drew's[14] case of a male, 56 years old, who was admitted to the hospital July 24th, 1896, under the care of Mr. Barker. For three and a half years at intervals he suffered pain resembling renal colic. Other symptoms were hæmaturia, at times quite profuse and a swelling in the abdomen which was probably due to a large tumor, evidently renal in the left side of the abdomen. On July 30th nephrotomy was performed but no stone was found. The patient died November 11th. The wound discharged much pus containing flakes of lymph which under the microscope were found to consist of renal epithelia and pus. The autopsy showed the right kidney slightly distended; the left much enlarged; the renal pelvis and calices greatly dilated; the lining membrane of the latter thickly covered with pinkish papillary growths; there were numerous whitish spongy nodules near the renal pelvis. The ureter was dilated and filled with pus. Along the length of the mucous membrane it was filled with tufts of delicate growths, attached by a narrow base. The bladder is small. A large red papillary growth is springing from the margin of the left ure-

teral orifice. In it is a cyst the size of a pea. The base of the villous growth does not infiltrate the wall of the bladder. Morris[15] in mentioning the case said that the growth in the renal pelvis was epithelial with cells of transitional type and those in the ureter were simple papilloma.

Case VI. Mioni's[16] case. A man, 34 years old, had suffered with kidney colic four years. For two and a half years he had painful hæmorrhage. The kidney upon palpation was very painful and the urine contained many erythrocytes, leucocytes and also numerous large cells of varied shape. The renal pelvis and calices were much enlarged. Both the kidney and ureter were removed to the bladder. The microscopic examination showed a typical papillomatous proliferation of the cylindrical epithelia of the renal pelvis and ureter. Several gland-like formations caused Mioni to diagnose the case "Adenocarcinoma papilliferum." Further progress of the case is unknown.

Case VII. Matsuoka[17] reports a case of papilloma of the renal pelvis from the surgical clinic of Tokio. The diagnosis was "pyonephrosis" and nephrectomy was performed. A purulent cystic kidney with villous growths of the renal pelvis was found. The villi are transplanted to the ureter and microscopically are located upon a connective tissue frame-work which is covered with a thick layer of epithelial cells. The description of this picture is very interesting, since it shows the transition from the benign to the malignant stage.

Case VIII. Hedenius and Waldenstroem.[18] The diagnosis showed bladder and kidney calculi. In the autopsy it was found that the renal pelvis was enlarged because the mucous membrane was covered with a mass the size of a hazel-nut; it was closely joined, uneven and composed of grayish-white, soft nodules. From the renal pelvis the neoplasms went to the ureter, the wall of which showed a thickness of 1.5 cm. In the histological pictures the neoplasms showed fine, connective tissue stroma, rich in large epithelial cells of varied forms

with large kernels and granular protoplasms. The bladder contained no stones.

Case IX. Derewenko's[19] case of a woman, 54 years old, who had noticed blood in the urine since the summer of 1902. In March, 1905, she was taken to the clinic and operated on the 29th for hæmatonephrosis. The kidney was not removed. There was no trace of a new growth. The patient developed pneumonia, then a suppuration and was dismissed June 20th. In September of the same year she was received again. The diagnosis based on the previous operation was unilateral hæmorrhagic nephritis and in October the left kidney was extirpated and the patient dismissed. In the hydronephrotic atrophied kidney were benign cauliflower new growths. Blood was again noticed in the urine nine months later and the patient received into the hospital. At the cystoscopic examination a papillomatous formation was seen projecting from the ureteral orifice. It was radically extirpated by opening the bladder. Scarcely one-half year after her dismissal she complained of lumbago, paraplegia, retention of urine, paralysis of the bladder and rectum. Later gangrene set in and after a few days the patient died. The autopsy showed a tumor in the left renal region which destroyed the second and third lumbar vertebræ and caused metastases in the liver and lungs. This new growth was called villous cancer and it was emphasized that it was different from the new growths found before in the ureter and renal pelvis. Derewenko is of the opinion that the benign papilloma of the renal pelvis caused metastases in the retroperitoneal lymph glands at the hilum and in the aorta, which remained latent. The ureter was entirely covered with proliferations and only after removal of the kidney and ureter did these malignant proliferations begin.

Case X. Savory and Nash[20] report a case by Barker of a man 56 years old who had villous carcinoma in the dilated calices and simple papillary tumors in the bladder and ureter.

Case XI. Cattani's[21] case of a man 63 years old with the following history: Immovable tumor of the abdomen, hæma-

turia with symptoms of cystitis and pyelitis; pains in the lumbar region; slight albuminuria; in the urine sediment were cancerous elements; cachexia, exitus. The cancerous infiltration originated at the beginning of the ureter; it was of grayish color and partly ulcerated. The tumor which was transplanted to the renal pelvis and had advanced to the cortex of the kidney was found to be a medullary carcinoma.

Case XII. Bradford's[22] case of a male, age 44, who was brought to the hospital October 1st, 1897, with a severe attack of delirium tremens and severe hæmaturia. Six months ago he noticed blood in the urine for one week. A large tumor was found in the left hypochondrium extending down to the umbilicus. The patient died October 5th. The postmortem showed that the tumor felt during life was the left kidney. There was a calculus in the renal pelvis, the mucous membrane of which was thickly covered with papillary benign growths, which extended into the ureter one and one-half inches. There was no epithelial ingrowth into the wall of the ureter and renal pelvis. A stone caused hydronephrosis.

Case XIII. Busse's[23] case, a man 61 years old. Prof. Häckel extirpated the kidney tumor under great difficulties. The operation was apparently successful but the patient died four weeks later. He had an abscess in the lung, and also hæmorrhage. The wall of the renal pelvis was covered with small, wart-like elevations on the mucous membrane with broad base or thin thread-like pedicle; similar ones were also present all over the mucous membrane of the ureter, thickest near its orifice into the bladder where a tumor the size of a hen's egg was found. There was a similar tumor in the bladder near the orifice of the right ureter and two smaller ones near the large tumor. That this was a benign tumor is known from the histological formation of the tumor, also from the patient's history. The suffering could be traced for twenty years.

Case XIV. Knowsley Thornton's[24] case of a woman 32 years old. She is said to have suffered with pain in the right

renal region since she was eight years old. Nine years before admission to the hospital she has occasional attacks of hæmaturia. During the last few months a tumor in the right side of the abdomen had become very painful. She had a cystic kidney. Nephrectomy was performed and the patient was up on the 22d day. The specimen is unique; the ureter is surrounded at the exit from the kidney by a papillary growth the size of a pea. It is capped by an olive shaped dark brown calculus. The openings from the calices into the renal pelvis are dilated, two are blocked by these smaller brown calculi. The patient made good recovery. Stüsser [25] in his report of the case classes it among the benign. He said that upon examination of the specimen it was found that there was a villous new growth which extended from the mucous membrane of the renal pelvis at the beginning of the ureter and in other parts of the renal pelvis. There was no histological description of the papilloma and nothing more is known of the case.

Case XV. Murchison's[26] case in a man aged 65 years. The patient had frequent hæmorrhage and pain. Other complications set in and the patient died. At the autopsy it was found that the base and surrounding of both ureters especially the right were studded with long, delicate, villous processes, not forming a distinct tumor. The ureter and pelvis of both kidneys were enlarged. The mucous lining of the ureter was free. The case was diagnosed as villous disease of the bladder. In the kidneys the same morbid processes had begun. Stüsser[27] classes this case among the benign and adds that at the autopsy it was found that both renal pelves were covered with long, villous tumors, and that in the lower part of both ureters kidney concretions were found.

Case XVI. Fenwick's[28] case of a man 70 years old, whose right kidney was removed on account of papillary growths in the renal pelvis and calices. He had suffered with hæmorrhage almost constantly for two years. At the end of the next year a recurrence was noted in the right ureter and this was removed. Watson and Cunningham[29] in their report of the

case state that the patient died uræmic four years later and that toward the end there was carcinoma of the prostate and squamus cell cancer, affecting the nephrectomy scar.

Case XVII. Picot[30] has recently reported a case of a man 53 years old who was brought to the hospital March 26th, 1912. Seven years ago he had two hæmorrhages, the following year five or six attacks and lately they had become more frequent and lasted longer. He also complained of continuous pain on the left side. The diagnosis based on a cystoscopic examination was: three tumors of the renal pelvis with secondary transplantation in the bladder. Nephro-ureterectomy was performed. The ureter showed neoplastic infiltration and also two tumors having the same characteristics as those in the renal pelvis. All these papillary tumors macroscopically have the same aspect as the vesical tumors recognized by the cystoscope. The patient stood the operation well and returned home May 11th.

Case XVIII. Israel's[31] case. Israel reports a case of a villous growth on the mucous membrane of the renal pelvis. Near the entrance to the bladder a new growth could be seen which covered the last 3 cm. of the ureter. The patient, a man 51 years old, had a severe hæmorrhage four years ago. Since then the attacks have been more frequent but less severe. He did not complain of pain nor colic, but by palpation it was felt that the kidney was enlarged. Retention of urine and the hæmorrhages had caused hæmatonephrosis. Nephro-ureterectomy was performed.

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[16] Stüsser: Beitr. z. klin. Chir., Tübing, 1912, LXXX, p. 563.
[17] Stüsser: Beitr. z. klin. Chir., Tübing, 1912, LXXX, p. 563.
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DISCUSSION

Dr. Hugh Cabot, of Boston: I recently had a case bearing rather closely upon the condition referred to by Dr. Caulk; a patient from whose left kidney a stone had been removed a year and a half before. Of the nature of the operation or the stone I know nothing. Discomfort more or less continuous, with attacks of pain, continued. I saw her first about three months ago. She is a woman of fifty. The kidney on that side showed a moderate grade of hydronephrosis, with a rather sharp kinking of the ureter. The kidney function on that side was very low, and secondary nephrectomy was done. On cutting the kidney the three upper papillæ showed distinct necrosis, and on these little areas of necrosis there was a calcareous deposit. It seems to me this bears very directly upon Dr. Caulk's work, and tends to confirm what I think we all believe, that necrosis is a very important factor in stone formation.

Dr. Edward L. Keyes, Jr., of New York: In reference to Dr. Lower's interesting paper, I venture, instead of reading the paper, which is next on the list, to report briefly one case that was to have formed part of that communication, a patient very similar to Dr. Lower's. The kidney which I took out would almost pass for the one which he took out, excepting that in my case the growth had burrowed through the parenchyma at its middle and made two great lumps in this which grossly resembled hæmatomata, but which were actually infiltrations of papillary carcinoma. This patient was a tuberculous young man, who had a severe hæmorrhage from the urinary passages about three months before entering the hospital. Following this hæmorrhage he had frequent and painful urination. The hæmorrhage then ceased, only to begin again, after which he alternated with frequent painful urination and hæmorrhage. He had a brother dying of tuberculosis of the lungs; his own lungs were infected, and the diagnosis was tuberculosis of one or the other kidney. It was with the object of confirming this diagnosis that I cystoscoped him, and to my great astonishment on putting him on the table for cystoscopy—I had not examined him before—and placing my hand upon his belly I noted that he had a distended bladder. Whereupon I put the sheath of the cystoscope into the bladder and sucked out what one would grossly call a bucketful of clots—a great amount of clotted blood. I then put the cystoscope in, and happily was able to get the bladder so clear that I could see a clot issuing from the right ureter

orifice, measuring by my graduated catheter about one centimeter in diameter. The kidney on that side was large and somewhat sensitive, but he never had had any symptoms in that loin, never any renal colic or pain. I sent him down stairs, thinking that he would be at peace because the kidney was probably shut off by the clot, and inasmuch as the hæmoglobin was down to about 50 per cent., I thought we could spend a few days feeding him up. Three days thereafter he had a violent hæmorrhage, the bladder filled up with clots again, and in spite of the emptying out of these, he continued to bleed, his red cells fell as low as 2,000,000, and it was obvious that we had better operate quickly, which we did. I realized the danger of implantation, spoken of by Dr. Caulk, but there was no time for complete ureterectomy. I simply snatched the kidney with a few inches of ureter—about as much as Dr. Lower got in his case. The result of the operation was satisfactory, excepting that the patient then took on a real tubercular taint and refused to get well. His hæmoglobin after operation was even lower than it had been before. He bled no more, but it took us about three months to get him out of the hospital. This in a way was fortunate for us, for at the end of that three months I was able to cystoscope him again, and still having in mind the possibility of implantation, to run a ureter catheter up and down his ureter in order to provoke hæmorrhage. I was unable to do this. The patient is now struggling with his pulmonary tuberculosis, eight months after his operation.

It seems to me that the theory of implantation down the ureter to account for any proportion of bladder growths, as it was advanced by Zuckerkandl, is rather farfetched, both on account of the rarity of the growths in the kidney pelvis itself, and also because the bladder growths that we ordinarily see grow from that portion of the bladder which is nearest the ureter to be sure, but which has a different embryological structure from the ureter; it is actually the fundus of the bladder within a fraction of a centimeter of the ureter, but not from the trigone where one would expect a tumor growing from ureteral or pelvic tissue to implant itself more readily.

Dr. R. F. O'Neil, of Boston: I should like to cite one other similar case which occurred at the Massachusetts General Hospital. The patient came in with a very profuse hæmaturia of six weeks' duration. Cystoscopy showed a large tumor situated at the base of the bladder between the ureteric orifices. He was so exsanguinated that a direct blood transfusion was done, this however improved his condition but little. The

tumor was removed by a suprapubic operation. Although the bleeding stopped he gradually failed and died a few weeks later. At autopsy the ureters and renal pelves presented the same picture of multiple papillomata which Dr. Lower's patient did.

Dr. Caulk: I was very happy to hear Dr. Cabot report his case of papillary necrosis with incrustations. I feel it is pretty definitely settled that necrosis is the prime factor in all such productions, no matter what the locality. Of course, the manner in which this impregnation takes place has not been yet definitely determined, and I have not been able to convince myself how it takes place.

I believe the most important point in the diagnosis of these ureteral incrustations is the passage of the catheter through the shadow or the obstruction, relieving the patient, with the persistence of the X-ray picture. A calculus probably would not do that unless incarcerated in the wall, and a sandy impaction would be removed so that there would not be enough left to cause a shadow.

Dr. Lower: I think the case Dr. O'Neil reported bears out the contention I am trying to make, that more complete postmortem might reveal the presence of tumors of the ureter or kidney pelvis more often than we see them. I think in this case if I had not observed bloody urine from the ureteral orifice, I might have concluded that the bleeding all came from the tumor in the bladder, and lost my patient through hæmorrhage, not realizing that she had any trouble in the kidney or ureter.

When tumors are situated in the region of a ureteral orifice, the possibility of a bladder transplant should always be kept in mind, and the ureter and kidney on that side should be examined. The appearance of a second tumor, situated at the ureteral margin so soon after the removal of the first tumor, as in this case, would make the suspicion all the greater.

A CONSIDERATION OF THE IMPORTANCE AND THE DIAGNOSIS OF THE TYPE OF KIDNEY KNOWN AS "INFANTILE"

By J. T. Geraghty, M. D., and H. G. Plaggemeyer, M. D., of Baltimore, Md.

THE different varieties of kidney anomalies generally recognized at the present day have been so thoroughly catalogued, and the classification so often repeated by various authorities, that the profession has come to be more or less conversant with the existence of such diverse abnormities, as well as with the diagnostic methods to be employed and the operative procedures to be followed.

We wish to describe here a type of kidney, which, when present, is of vital importance to the surgeon, as it may easily pass unrecognized, when ordinary methods of examination are employed. The particular anomaly to which we refer is the condition in which a large hypertrophied kidney exists on one side, and a small, insufficient kidney on the other, the urine from the insufficient kidney, as far as ordinary chemical and microscopic methods of diagnosis are concerned, appearing entirely normal, as also the concentrating ability. The quantity of urine and the function, however, are so small that this kidney, of itself, is insufficient for life. While a search of the literature reveals a comparatively small number of cases, in which nephrectomy has been performed unwittingly on the larger kidney, with disastrous results, the condition is, nevertheless, probably much more common than the number of reported cases would indicate. In the first place, surgeons who have been unfortunate enough to have experienced such an untoward result, are naturally not too prone to report these cases. We have personal knowledge of several unreported cases in which death has followed nephrectomy and autopsy has demonstrated an apparently normal, but small, insufficient kidney on the opposite side. In the second place, a large num-

ber of these cases are undoubtedly described under the head of secondarily atrophied kidneys, and there must of necessity be a far larger number of cases in which the patient has died of renal insufficiency and autopsy has not been obtained.

Of course, the differentiation between secondarily atrophied kidneys, insufficient as the result of pathologic process, and the insufficient kidney secreting normal urine in small quantities, is of little practical importance to the operating surgeon. Either is incompatible with life, if found in marked degree, should nephrectomy be performed on the opposite side. But the danger of this type of organ lies in the fact, that *an anomalous kidney can exist which will secrete a perfectly normal urine.* The existence of such a kidney will be recognized, only in those instances in which the examiner is familiar with the possibilities of this condition, and, keeping that possibility always before him, will not be satisfied with finding a urine microscopically and chemically within range of normal, but will take advantage of the additional diagnostic methods at our command, particularly estimation of the functional capacity.

Papin in a very complete consideration of all possible kidney abnormities mentions briefly the type of organ to which reference is made. He describes such an organ as secreting a urine, normal in every respect, except that the amount is very small. He mentions specifically that such a kidney may even have a high urea concentration. McArthur reports a case in which he had performed nephrectomy for tuberculosis, which was followed by death from renal insufficiency, and at autopsy, a kidney which he terms "infantile" was discovered. The ureters in this case had been catheterized previously, and a perfectly clear, apparently normal urine obtained from the insufficient kidney. He also expresses the evident hopelessness of being able to diagnose this condition before operation.

The frequency in general of kidneys atrophic through various causes is best seen by a comparative study of the pathological reports from different hospitals. In a study of 3,940

autopsies from the pathological department of the Johns Hopkins Hospital, we have found 36 cases of atrophy from various causes. Of these, six cases only were unilateral. In this classification, the comparatively slight bilateral diminution in size through chronic nephritis, found in some cases, was naturally omitted.

All forms and degrees of atrophy considered together, in a ten year classification, embracing autopsies from Guy's Hospital, Middlesex Hospital and the Great Ormond Street Hospital, London, the condition was found 60 times in 8,178 subjects. A study of the frequency of malformation, by which we understand congenital diversion from the form and size of an organ, gave the following results:

The Guy's Hospital report of autopsies for ten years showed in 4,632 cases, a total of 14 cases of malformed kidneys, but the total number of "wasted" and "shrunken" kidneys catalogued is 47. None of these cases, however, was considered as of congenital origin.

In the Middlesex Hospital, the ten year classification showed in 2,610 bodies, 19 malformations. Among these were six congenital unilateral atrophies and four unilateral atrophies from disease. Of the four cases from disease, one was entirely atrophic; in another the kidney was so small that scarcely any renal tissue was left.

As regards congenital absence: In Guy's 4,632 cases, there was one case of congenital absence. This was in a man of 40. In the Middlesex Hospital list of 2,610 cases, and in St. Bartholomew's 3,800, there was no case of congenital absence or undeveloped rudiment. In the Great Ormond Street Hospital series of 936 autopsies on children, there was one case of congenital absence, and one case of extremely defective development, the latter occurring in a child with imperforate rectum, which lived five days only.

Added together, these figures amount to 11,978 cases in which there were three cases of absence or extreme atrophy of one kidney. This gives us a ratio of 1 to 3,993 cases. A

compilation of the collected cases of R. F. Wier and O. Peterson gives us a ratio of 1 to 3,250, which is well within the range of the statistics shown above from the different London hospitals.

Norris' classification shows 59 shrunken kidneys in a series of 8,178, or, 1 to 139. Our study from the Pathological Department of the Johns Hopkins Hospital shows 36 cases in 3,940 autopsies, or a ratio of 1 to 110. The relationship of these two series of figures is rather striking.

It may be assumed then that the probability of a person having only one kidney owing to congenital absence or non-development, is excessively small. There is much greater risk of meeting with a horseshoe kidney, or otherwise fused renal mass, and a still greater risk of finding the kidney, or kidneys, atrophied from disease, or congenitally small.

None of the above statistics, however, take into account those congenitally small, or atrophied kidneys, which weigh from one to one and one-half ounces and may possess some, though not a full amount of glandular substance. Congenital aplasia and hypoplasia of extreme degree are practically the only types, which are considered, in the various statistics available. No account is taken of the frequency with which one may encounter a type of kidney, neither aplastic on the one hand, nor on the other the result of a definite retrogressive atrophic change, but presenting an amount of renal tissue so small as to be incompatible, or, at best, barely compatible with life. There are gradations of deficiency between a normal kidney on the one hand and aplasia or marked hypoplasia on the other.

The material on which this study is based comprises three cases obtained at autopsy in the Pathological Department of the Johns Hopkins Hospital, one case from the Hunterian Laboratory, two cases in which the condition was discovered at the operating table, and two cases, diagnosed clinically as anomalies of this type.

It is not our purpose in this paper to consider, in any de-

tail the cause of atrophy of the kidney, nor to formulate a classification of atrophied, or congenitally defective kidneys, but to call attention to the fact, that a type of atrophied kidney which may be inconsistent with life can exist, which secretes an apparently normal urine. Furthermore, on gross examination, these kidneys have not the characteristics usually seen in the so-called *Schrumpfnieren*. In shape, color and external appearance, they are apparently perfectly normal, with the exception of the diminutive size. The surface is smooth, and the capsule non-adherent, and, on section, the kidney, to the naked eye and casual inspection, presents an appearance practically normal. Notwithstanding this apparently normal kidney tissue, the organ lacks entirely the power of taking up increased function under stress.

Report of Cases

Following is a description of the material on which our studies are based:

Case I (Plate V, Fig 1). The first specimen consists of the kidney of a cat. Some experiments were being done to determine how quickly the remaining kidney could take up the total function after nephrectomy, the function being tested by means of phenolsulphonephthalein.* When nephrectomy was performed, it was noted, that the kidney seemed unusually large for a cat. Following the removal of the kidney, the amount of urine serceted decreased at once, and the function dropped to one-fifth of the previous amount. This result was strikingly different from the other experiments previously done, in which the remaining kidney almost immediately assumed a function equal to that of the two kidneys. Following the examination, the cat was killed, and the cause of the great drop of the kidney function was revealed by finding an extremely small kidney, which weighed 6.4 gm., while the opposite weighed 26.4 gm. There was no abnormality in the urine.

* Rowntree and Geraghty, Archiv. Int. Med., 1912, page 80.

PLATE V.—Presented by Dr. J. T. Geraghty and Dr. H. G. Plaggemeyer

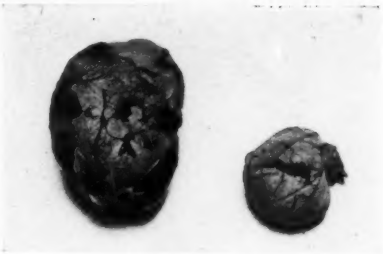

Fig. 1

(Case I) Cat's kidneys.

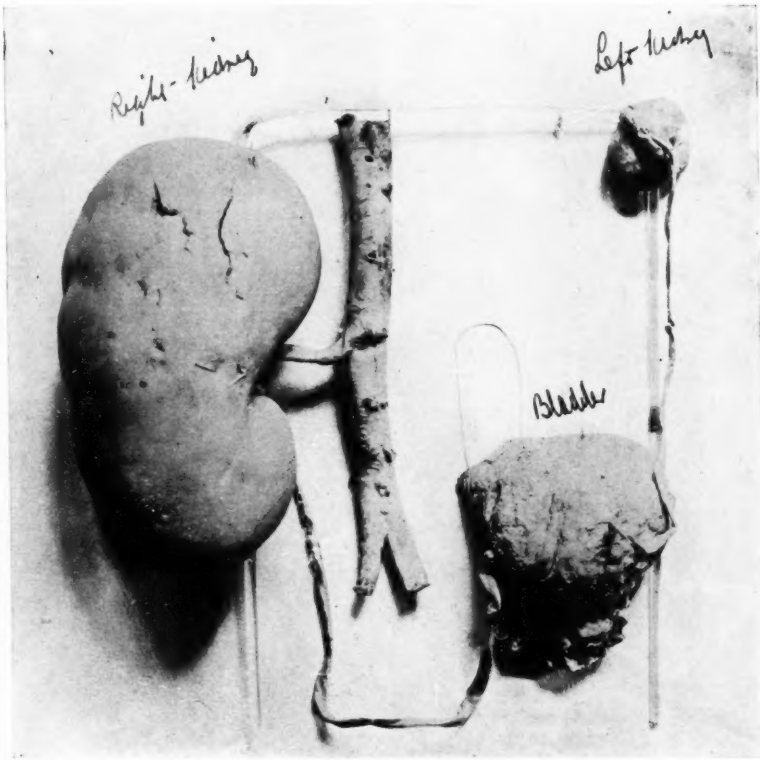

Fig. 2

(Case II) Specimen from Pathological Laboratory, Sections described under Case II.

Description of kidneys: In this case there is a great disparity between the size of the kidneys. The left measures 4 x 3½ x 2½ cm.; the right measures 2 x 2 x 1¼ cm. The capsule of the kidneys stripped readily leaving a smooth surface, on which nothing abnormal is to be seen. On section, the three zones of the kidney may be made out quite readily. The cortex in the large kidney measures 5 mm., in the small kidney 2 mm. and nothing abnormal is to be seen in either case.

Microscopically: Section of the large kidney shows huge glomeruli and large uniferous tubules, which, despite their increased size, bear a definite and normal proportion to each other. The blood vessels show nothing abnormal, and there is no increase in fibrous tissue, or scarring in the organ. In the small kidney, the picture is quite different. Definite scars may be seen radiating out from the arcuate vessels to the surface. These scars appear to be associated with the interlobular blood vessels. In the scarred area the tubules are atrophic or entirely gone, and there is infiltration of mononuclear cells, which, however, is not very marked. Here and there in such scarred areas, hyaline glomeruli may be seen. The hyalinization of the glomeruli, is, apparently, one which begins in the capsule and only involves the tubules secondarily. In the intervening spaces, both the uriniferous tubules and glomeruli are normal in appearance. The blood vessels show some thickening throughout, and it is impossible to determine in the section, whether there is any absolute relationship between the scarred areas and the thickened blood vessels. The impression that one would get from the examination of the section of these two kidneys, from the standpoint of their secretory ability would be somewhat similar to that described in the next case. The small kidney certainly is functionally insufficient, as is manifest from the fact, that there has been such a hypertrophy of the other kidney. On the other hand, it may be quite possible, that the small kidney might secrete urine, which, though quantitatively insufficient, might be qualitatively normal.

Case II (Plate V, Fig. 2). Left hypertrophy; right atrophy. This case is a specimen in the Pathological Museum of the Johns Hopkins Hospital. Unfortunately, no history is obtainable and we are not supplied with clinical data as to the presence of associated lesions, but the case is of interest from the pathological findings alone.

The specimen consists of the abdominal aorta, the kidneys and ureters. The renal artery on the left side is present, but that on the right side is no longer to be found. The urinary bladder is quite normal as are also the ureters. The striking thing about the specimen is the great disparity between the size of the two kidneys, the right on the one hand being fused, while the left is extremely small. The relative measurements are as follows: the right kidney measures 15 x 8 x 6 cm., the left 3½ x 2 x ¾ cm. The capsules of both kidneys stripped quite readily, leaving smooth surfaces. The surfaces are discolored on account of the alcohol fixation. Section of the right kidney shows a cortex which averages about one cm in width. The pyramids are pale, but seem normal. There is some increase of fat around the pelvis. In the gross, aside from the huge size of this organ, nothing abnormal is to be seen. The left kidney, on the other hand, is very minute, and on section the architecture is partially obscured. One can only see that the renal parenchyma forms a thin shell, and that the pelvis is slightly dilated.

Microscopically (Plate VI, Fig. 1): Sections from the right kidney show the usual findings in the kidney that has undergone compensatory hypertrophy. The structures are all quite regular in appearance, but are considerably increased in size. The glomeruli are large, but the proportion between the tuft and the entire glomerulus is normal. The tubules likewise are dilated. Their epithelium, however, is not so greatly increased in height. There is nowhere any increase in fibrous tissue throughout the organ. No scarring is to be made out. The blood vessels are everywhere delicate in appearance and

PLATE VI.—Presented by DR. J. T. GERAGHTY AND DR. H. G. PLAGGEMEYER

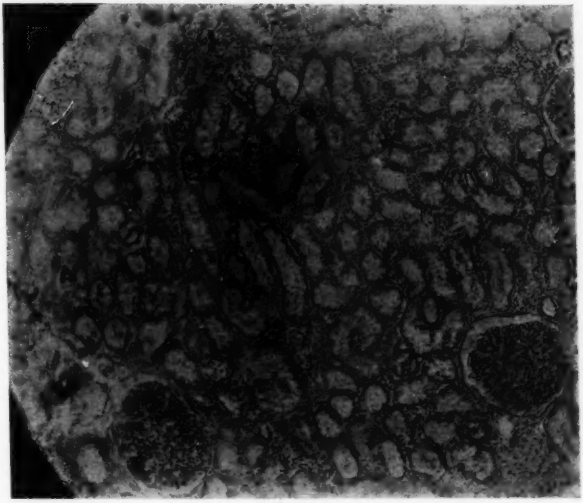

Fig. 1

(Case II) A large kidney, from Pathological Laboratory. Slight diffuse increase in connective tissue. The tubules and glomeruli show no change except thickening of capsules.

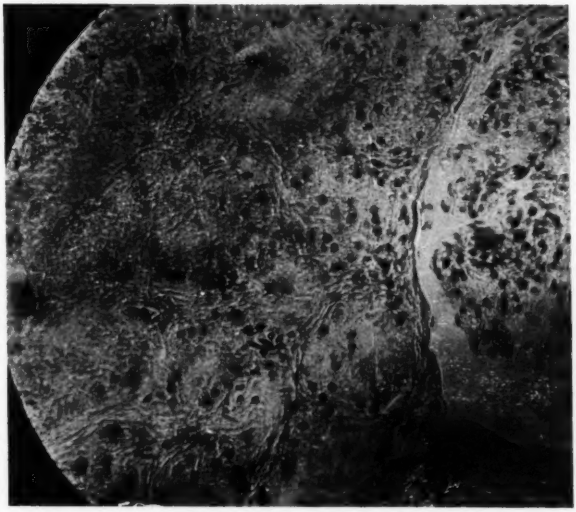

Fig. 2

(Case II) Small pathological specimen. This is a poor section. The kidney under the microscope gives distinct evidence in many parts that it is capable of putting out normal urine.

aside from the huge size of the individual structures of the organ, nothing of importance may be seen.

Section made through the entire half of the left kidney shows a quite different picture (Plate VI, Fig. 2 and Plate VII, Fig. 1.) There is considerable distortion of the tissue, and it is quite difficult to ascertain whether one is examining cortex or pyramids. This is due to the fact that there is only a very minute amount of cortical tissue, and throughout the whole of the section only a few glomeruli occur. These glomeruli that are present, however, are enlarged and have exactly the same appearance as those described in the hypertrophied kidney on the left side. Associated with these glomeruli and usually in their vicinity, are a number of convoluted tubules which also show no great abnormality. The great mass of the section is composed of a number of tubules which look much more like collecting tubules than like convoluted tubules. The most striking thing about the section is the fact, that, at the periphery and surrounding the entire circumference of the section are a large number of blood vessels which are usually situated in a mass of hyaline fibrous tissue and which have very dense, thick walls and very minute lumina. This impresses one as though there were a compensatory endarteritis and obliteration of the blood vessels at the cortex of the kidney. They look as though they were in the position of the normal arcuate and interlobular arteries, and that, on account of the lack of development of the cortical substance, it is possible that the vessels have undergone a secondary obliteration. The appearance of the right kidney suggests, that it has been producing a large amount of urine, and that it has undergone a compensatory hypertrophy. Concerning its functional capacity, this must have been great.

Case III. M. E. T., age 48 years. Diagnosis, stricture of left ureter. Admitted November 14th, 1912. Readmitted May 10th, 1913. On the first admission, a diagnosis of perireteral thickening on the left side was made under ether examination, but the patient refused operation. On being re-

admitted, the complaint was puffiness of the face and vomiting. She died a few weeks after last admission with the symptoms of acute nephritis.

Family history: Negative.

Past history: Negative.

Present illness: August, 1911. Twenty months ago patient first noticed blood in the urine. This appeared at intervals until October or November of the same year. At the time of hæmaturia, patient had short attacks (20 to 30 minutes) of dull, aching pain in the left lower abdomen, at times radiating to the left leg. This was relieved by hot vaginal douches and stopped spontaneously. During the winter of 1911, had no blood in the urine, but in January, 1912, it recurred, since which time it has been more frequent. Pains have been more severe. During one attack of pain, patient vomited repeatedly, but there was no typical history of renal colic. Has not lost weight, nor has she felt ill.

During the last two weeks patient has been confined to her bed; has been voiding in small amounts and the face and eyelids have been puffy. The tongue has been exceptionally dry and patient has had frequent attacks of vomiting, the vomitus being of a coffee-ground nature.

Physical examination: Ether examination by Dr. H. A. Kelly, November 15, 1912, showed what he thought at first to be a stone, but later decided to be an inflammatory thickening over and around the left ureter. The bladder urine was light in color, specific gravity 1010, alkaline reaction, sugar negative, albumin negative, no sediment. On ureteral catheterization, October 16th, 1912, the left kidney urine specific gravity was 1008, sugar negative, albumin negative, no sediment, alkaline. The left kidney urine showed urea 4 grammes per litre and the bladder urine gave 3.5 grammes per litre. At autopsy there was found a slight constricting band in the lower portion of the left ureter with a small hydronephrosis of the left kidney, but scarcely large enough to be distinguished by the naked eye, the diagnosis depending upon the

microscopic description found around the calices and the continuous beginning pressure atrophy. The left kidney weighed 140 grammes and the right kidney 40 grammes. Both were absolutely normal in general appearance and structure.

Anatomical diagnosis: Acute hæmorrhagic and slight chronic diffuse nephritis; chronic ureteritis (left) with stricure, hydroureter and hydronephrosis.

Left kidney: Weight 140 gm.; size 10½ x 5 x 3½ cm.

Right kidney: Weight 40 gm.; size 5 x 2¾ x 1⅓ cm.

Left kidney capsule strips readily, with some hæmorrhage between the capsule and cortex. The cortex varies from 1 to 2 mm. in width. In some places it is merely an outline. The pelvis is markedly dilated, the dilatation involving the parenchyma, and causing some pressure atrophy. The surface shows definite infection and some small hæmorrhages. On microscopic examination, the glomeruli are slightly larger than on the opposite side, but not quite as large as normal, showing definite signs of pressure from below. There is much fibrosis, and tubular hæmorrhage with casts of hæmoglobin are seen, and throughout the section there is marked dilatation of the tubules. There is some round-cell infiltration and here and there glomerular adhesions are seen. It is probable that here the same type of nephritis is found on both sides.

Right kidney: The capsule strips with slight difficulty, leaving a finely granular surface on which a few ecchymoses are found. The fœtal lobulation remains. The cortex is 3 mm. in thickness; the striations are fairly straight, and the pyramids are apparently normal throughout, except that there is a slight irregularity in the tubules from pressure of hæmorrhagic origin. Microscopically, there is a slight increase in interstitial tissue but not nearly so marked as on the opposite side. There is some diffusion of red blood corpuscles, in localized areas, and here and there are found definite areas of round-cell infiltration, which would suggest a previous chronic condition. The capsule of Bowman is practically normal throughout except for a very slight thickening of the margin.

In places there are a few fairly well defined adhesions between the glomeruli and the capsule. The tubules are small with low columnar epithelium and the lumen is obscured in places. There are large areas of normal glomeruli and other areas containing glomeruli which are practically hyalinized. In the pelvic portion there is no increase in fibrous elements, but there is some round-cell infiltration. In this kidney we have evidently an acute diffuse nephritis of a mild grade built up upon a previous chronic condition. Microscopically, however, this kidney is not nearly so badly affected as the opposite large kidney.

This small right kidney on gross examination is a typical picture of a normal kidney of the infantile type. While the microscopic examination shows a mild acute diffuse nephritis, probably secondary, or at least concommitant with a much more marked condition on the opposite side, this fact does not affect our consideration of the subject. The infection on this side, and the influences following it were evidently much less marked than on the opposite side, and yet, this kidney which under the microscope is much more nearly normal than the other, presents a bulk of only 40 g. of normal urine-producing tissue, while the other side, having a fair amount of hydronephrosis from a stricture 5 cm. from the orifice presents a bulk of 140 gr. in weight, and a microscopic picture much more exaggerated than on the small side. It is interesting to note that both the catheterized specimen of urine and that taken from the bladder were apparently normal, but it is to be regretted that the functional test was not done. This case presents in a startling way the dangers to be considered in spite of the presence of an apparently normal urine.

It is of interest to note here that the combined weight of the kidney substance is 180 gm., very little above the average normal weight of a single kidney. Here the small right kidney would have every reason to hypertrophy in order to make up for the deficiency on the other side, if it had the power of compensatory enlargement, which seems, however, to be lacking

PLATE VII.—Presented by Dr. J. T. Geraghty and Dr. H. G. Plaggemeyer

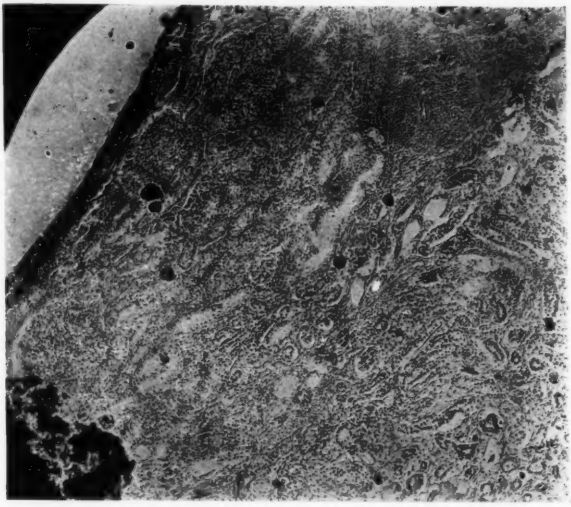

Fig. 1. (Case II) Small pathological specimen. Low power. There are in this section three large glomeruli, all jammed up against the capsule, of which latter there is a slight thickening. All of these glomeruli are much hypertrophied.

Note: The small black masses are artifacts

Fig. 2. (Case IV.) Weight of left kidney 180 Gr.
Weight of right kidney 40 Gr.

PLATE VIII.—Presented by DR. J. T. GERAGHTY AND DY. H. G. PLAGGEMEYER

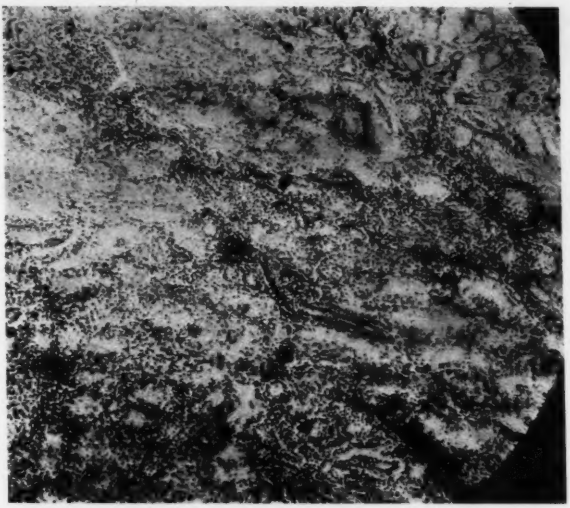

Fig. 1. (Case IV.) Large kidney, low power. Under the microscope this section looks much better than the picture portrays. There is a slight increase in connective tissue and considerable round cell infiltration. Many of the tubules contain homogeneous pink-staining masses, but in great part the tubules have a normal epithelium.

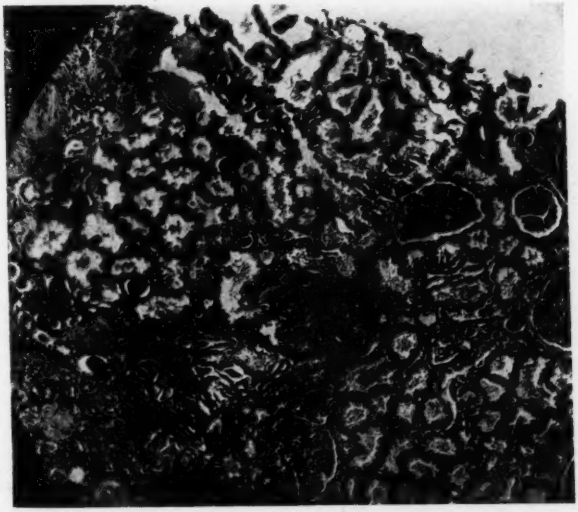

Fig. 2. (Case IV) In this picture there are four absolutely normal glomeruli, showing a minute change in the capsular wall. The granular debris in the tubules is probably albumin. (Ante mortem.) In the lower left-hand corner, the tubules present a flattened epithelium and the lumina contain uniform pink-staining masses. Here the increase in connective tissue is well marked.

in this type. The left kidney, on the other hand, shows very little secreting parenchyma. The fact that there are present a certain number of large glomeruli, and that these are associated with relatively, normal convoluted tubules suggests, however, that this kidney, too, has probably been functioning, evidently to a minute degree, and has been pouring out urine normal in its qualitative content.

Case IV. Kidneys of a man aged 70, who had hypertrophy of the prostate for a number of years. On admission to the hospital, November 17, 1912, he was found to have an infected urine and a markedly decreased renal function, as follows:

November 17th. Appearance time 30 minutes. At the end of one hour, 1 per cent. of phthalein was recovered in the urine; and at the end of the second hour 5 per cent was recovered. The lactose was negative at 12 hours; urine diastase normal; blood cryoscopy .59. Under treatment with a retention catheter, forced water, etc., the renal function increased markedly until November 30th, thirteen days after admission, the first appearance of phthalein in the urine was reduced to 20 minutes after injection; 15 per cent. being recovered in the first hour against 1 per cent. previously; and 10 per cent in the second hour as against 5 per cent. previously, or the total output was 25 per cent. as against 6 per cent. on admission.

Following perineal prostatectomy, the patient died from hæmorrhage, and at autopsy the kidneys were as follows:

Macroscopic examination: (Plate VII, Fig. 2.) The right kidney measures 7 x 3½ x 2¾ cm. Weight 40 gm. The left measures 11 x 6½ x 4 cm. Weight 180 gm.

Left kidney (Plate VIII, Fig. 1). Capsule strips readily, leaving a granular surface, with scattered mottled hæmorrhages. In the mid portion of the convexity of the kidney, there is a depressed scar whose surface measures 2 x 1 cm. On section, the cortex is found varying from 6½ to 1½ mm. in width. The striations are obscure and irregular and in part obliterated. Retention cysts are found not only in the cortex but also in the pyramidal portion. The cortex is almost en-

tirely gone in the region of the scar, and the pyramidal portion shows a definite increase in gray, translucent connective tissue. The arcuate vessels are very prominent, but not as prominent as on the other side, although arteriosclerosis is definitely present. The pelvis is moderately dilated, and below the lining membrane there are scattered ecchymotic spots.

Right kidney. Capsule strips readily, leaving a granular surface mottled with minute hæmorrhages. Scattered throughout are fairly numerous retention cysts. On section, the cortex is found markedly irregular in width and, in places, varying from one to four mm. The striæ are extremely irregular where present, but are, however, for the most part absent. On cross section, a small circumscribed tumor is seen lying in the cortical zone, of the size of a lemon seed. The mass is well circumscribed, yellowish in color and surrounded by a fine, grayish translucent coat. This is adenoma. The arcuate vessels in this kidney are astonishingly prominent, the walls definitely thickened and gaping. The pyramidal portion shows nothing unusual. The pelvis of the kidney is markedly dilated with many ecchymoses below the lining epithelium.

The right kidney is similar in many respects to the left, being, however, many times smaller. If anything, the smaller arterial branches show greater thickening than on the left, and the pelvis is comparatively large on this right side.

Microscopic examination: (Plate VIII, Fig. 2 and Plate IX, Fig. 1.) Right kidney. The striking thing in the section is the marked thickening of the vessel walls, leaving, in many cases, but a small lumen. Most of the glomeruli are apparently intact and show no more than a moderate thickening of the capsule. About these intact glomeruli, the tubules show an intact epithelium, the cells being of good size, nuclei and cytoplasm staining well. They contain, however, a moderate amount of granular pink staining debris; a few only containing a uniform pink-staining material. In the greater portion of the section, however, the tubules show a marked flattening or atrophy of the epithelium, and contain a homogeneous pink-

staining mass. The vessels in the arcuate region show marked thickening of the intima and media, and, in places, there is beginning calcification of the intima. This is the ordinary type of arteriosclerosis and is not luetic. In this region there are numerous areas of round cell infiltration.

Both of these kidneys are the seat of a typical, moderate grade of arteriosclerosis with a localized pyelonephritis, and the process is of about equal grade in each kidney. The very marked difference in the weight and size of the kidneys cannot be explained satisfactorily as being secondary to the evident pathological process present in each kidney, as the amount of disease present would not explain this marked atrophy on the right side. It seems much more probable, that a considerable discrepancy existed in the size of the two kidneys, before the onset of the present pathological processes, particularly as the left kidney, although the seat of the chronic nephritic, and inflammatory changes, has a weight, considerably in excess of the average normal kidney. This enlargement of the left kidney must have been present before the onset of disease, as it is known that kidneys, which are the seat of a diffuse pathologic change do not undergo compensatory hypertrophy.

Case V. Male, age 39 years. Admitted to Johns Hopkins Hospital May 16th, 1910. Diagnosis, tuberculosis of right kidney.

The left ureter was readily catheterized; the right ureteral orifice being markedly ulcerated, it was impossible to pass the catheter, so the urine was collected transvesically. An injection of phthalein was given intravenously, and collection made for one hour, the findings being shown below.

RIGHT SIDE (Across bladder)	LEFT SIDE (Ureter catheterized)
20 c. c.	40 c. c.
Cloudy.	Clear.
Specific Gr. 1016.	Specific Gr. 1020.
Urea 1.7 per cent.	Urea 2.8 per cent.
Phthalein appearance time 18 minutes; amount recovered 1 per cent.	Phthalein appearance time 4 minutes; amount recovered 44.4 per cent.

At operation a very small right kidney was found and nephrectomy performed. (Young.) The kidney measured 7½ x 3½ x 2½ cm., and the weight was 40 grammes. The surface of the organ appeared normal. The capsule was not adherent and the color was normal. On palpation, the lower third seemed softer than usual, but the consistency of the remainder of the kidney was good. On being sectioned, the cortex was found very irregular in width, varying from two to two and one-half mm. and presents a slightly irregular surface with depressions and elevations of varying size. There are many scattered cysts on the surface, averaging from the size of a pin-head to a pea. In the region of the surface elevations, the cortex is about normal in width and the striæ are fairly irregular; elsewhere the striæ are very irregular and obliterated. Some of the depressions are associated with cortical scars, or bands, of gray translucent tissue. The pelvis is lined with a thick white skin-like epithelium, and the relative size of the pelvis seems distinctly greater than one would expect. (A pelvis with epithelial covering of this type is extremely rare, and is possibly congenital in origin.) The upper third of this kidney shows well marked tuberculosis between the pyramids and cortex, with small cavity formations. The macroscopic appearance of the lower two-thirds is apparently normal. There is no flattening of the papilli, and, as far as one could say from gross examination, the kidney tissue is normal in appearance, the only abnormality being the diminutive size.

Microscopic description: (Plate IX, Fig. 2, and Plate X, Figs. 1 and 2.) There is a slight diffuse increase in connective tissue, manifest mostly about the glomerular capsule; the tubular epithelium is somewhat swollen, and the general architecture slightly blurred. The lumina of the tubules are filled with a finely granular pink-staining material. Many of the glomeruli are intact, the only abnormality noted in them being a slightly thickened capsule, many others, however, show moderately thickened capsule and fairly numerous glom-

PLATE IX.—Presented by Dr. J. T. Geraghty and Dr. H. G. Plaggemeyer

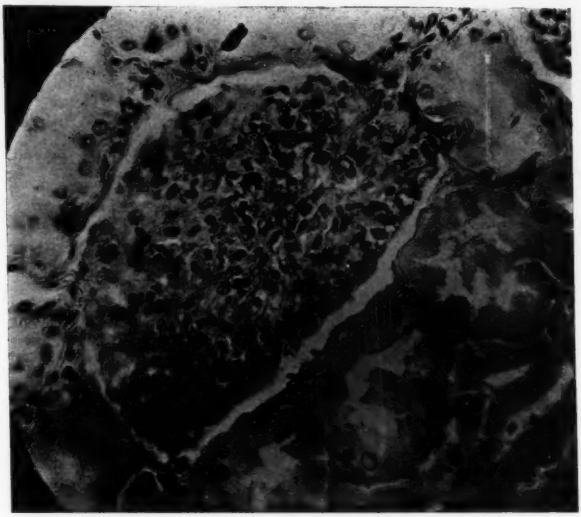

Fig. 1

(Case IV.) This glomerulus under high power is practically normal, except that the capsule is very slightly thickened and is surrounded by convoluted tubules having a well staining nuclei throughout.

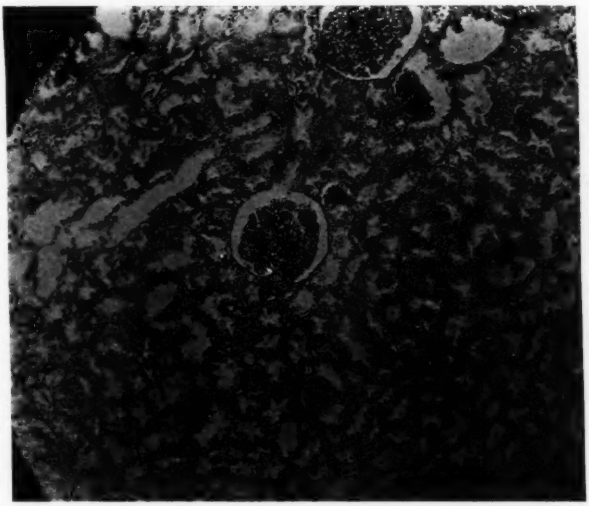

Fig. 2

(Case V.) Normal kidney.

PLATE X.—Presented by Dr. J. T. Geraghty and Dr. H. G. Plaggemeyer

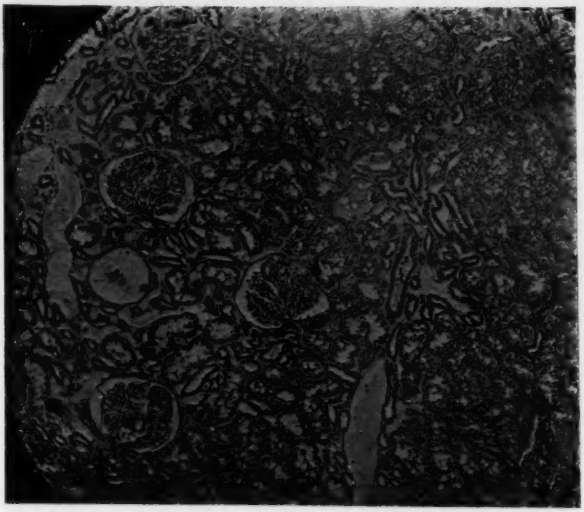

Fig. 1. (Case V.) Compare Fig. 2 on Plate IX. Here, too, one glomerulus is wanting as in the normal case. In this photograph, the nuclei are not so sharp, as the picture unfortunately is not absolutely in focus.

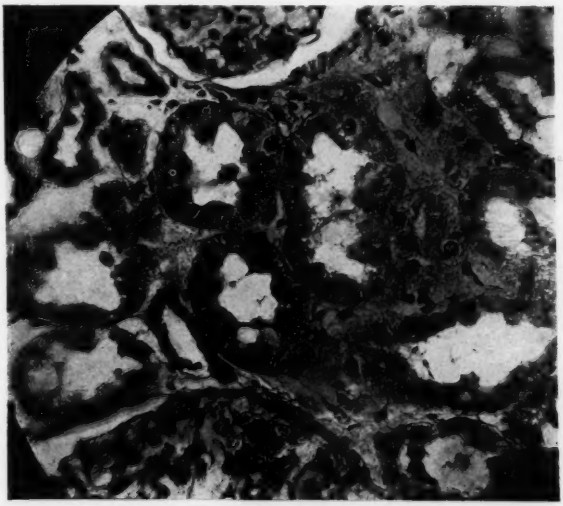

Fig. 2. (Case V.) Well-stained nuclei and fairly well formed cells. Very slight but definite arteriosclerotic change in capsule of kidneys.

erular adhesions. As a whole with the exception of the tuberculous portion, the pathological changes present are very minute.

In this case, the high urea concentration with the low function, is of particular interest, as the urine from the right kidney had to be collected across the bladder, and as no particular care was taken to entirely drain the bladder, a slight dilution of the urine from the right kidney undoubtedly occurred, so that the 20 c. c. apparently obtained from the right kidney, represented some salt solution intermixed. The concentration of the urea and the specific gravity, though both high, were probably, in reality, still higher. The relatively high urea concentration and the extremely low phthalein are apparently at variance, but the study of the specimen explains the apparent discrepancy. The amount of the kidney tissue being small, gives a low functional output.

It may readily be seen, that, if in this case the disease had been in the hypertrophied left kidney instead of in the right kidney, it is probable that nephrectomy, if performed, would have resulted in death. The deficiency in this right kidney would not have been recognized except through a functional test.

Case VI. W. D. S., age 30 years; male. Diagnosis: tuberculosis of right kidney; atrophic left kidney. The patient was first seen in March, 1909, complaining of frequent and painful urination. A diagnosis of vesical tuberculosis was made at the time, tubercle bacilli being demonstrated in the urine. The prostate, seminal vesicles and epididymis were apparently normal. Ureteral catheterization was advised but refused. Six months later, he reappeared with urination so frequent and painful, and bladder so contracted, that ureteral catheterization was impossible. Suprapubic drainage was established for relief of symptoms, and the bladder drained for several months. He then went to a sanitarium, and his general health improved, as did also his urinary symptoms.

In February, 1911, he was again seen; the bladder was so

contracted that ureteral catheterization, although attempted, was unsuccessful. Estimation of the total function, by means of intramuscular injection of phenolsulphonephthalein, showed an appearance time of eight minutes, and an excretion of 36 per cent. for one hour and ten minutes, which, at once, suggested the probability of a bilateral lesion. Because no focus of infection could be found in the prostate, seminal vesicles or epididymis, it was thought most probable that one or the other kidney was the primary seat of disease. Consequently a double exploratory operation was advised. The left kidney was first exposed and it was discovered that this kidney was about one-fourth the size of a normal kidney. In every other respect the organ seemed normal. There were no perineal adhesions; the surface of the kidney was perfectly smooth, and the consistency normal. The ureter showed no thickening or induration suggestive of tuberculosis. In view of the reduced total phthalein output, and the deficient capacity in the kidney of the left side, it seemed very probable that the tuberculous process was present in the hypertrophied kidney on the opposite side. If this hypertrophied right kidney were the seat of a tuberculous process, it was also very evident that nephrectomy could not be performed on that side because of the deficient kidney on the left. Consequently the right kidney was not explored.

The patient subsequently returned to his sanitarium and was not seen again until April, 1913. His general health in the meantime has been fairly well maintained, and urination, while very frequent, is not as marked as some years previously. The urine is quite cloudy from pus and the total estimated renal function by means of phenolsulphonephthalein shows an excretion of 25 per cent. for one hour and ten minutes.

It seems very probable that the tuberculous process in the right kidney as it advances, is causing a decrease in the total

function owing to the inability of the left kidney to assume the function of the right.

Case VII. Male, age 27 years. Diagnosis: Tuberculosis of the right kidney; atrophic left kidney. Admitted with a history of urinary frequency of ten months' duration. The bladder urine is cloudy, and contains much pus; large numbers of tubercle bacilli are readily demonstrated. The bladder capacity is 50 c. c. The right ureteral orifice is œdematous, and the right half of the trigone shows marked ulceration and congestion. The left half of the trigone appears normal.

The collection of urine was for one-half hour, 6 mg. of phenolsulphonephthalein being given intravenously. The result of ureteral catheterization was as follows:

RIGHT	LEFT
80 c. c.	4 c. c.
Cloudy.	Clear; good color.
Much pus.	Microscopically negative.
Many tubercle bacilli.	Phthalein appeared in 10 minutes; amount recovered 8 per cent.
Phthalein appeared in 5 minutes; amount recovered 30 per cent.	

The left kidney functioned very slowly, and in order to confirm the above findings, catheterization was repeated some days later with almost identical results. An estimation of the total function was also made, and 35 per cent. of phthalein was recovered in one hour and ten minutes, after intramuscular injection of 6 milligrammes.

In view of the fact, that the apparently normal left kidney had only one-fourth the function of the tuberculous one, it seemed advisable not to perform nephrectomy without further observation. The decrease in the total function, of itself, indicating a bilateral lesion. The right kidney, although positively tuberculous, still retained a function, equal to that or even greater than that of a perfectly normal kidney, which indicated that, previous to the onset of disease in this kidney, it was hypertrophic. Of course, the possibility that we are dealing here with a walled-off tuberculous lesion in this left

kidney, with an active process in the right, will have to be conceded, although, in view of the fact, that the urine was perfectly normal in character and free of pus cells, this condition is rendered very improbable. It is difficult to conceive of a tuberculous lesion sufficiently extensive to destroy more than half the functioning substance of the kidney, and then becoming walled-off, leaving the ureter and pelvis perfectly normal. Furthermore, the ureteral orifice, and the left half of the trigone are free from disease. X-ray was negative for stone, but showed a kidney shadow on the left side not quite half as large as the shadow on the right. There was no evidence of calculus.

The normal character of the urine, on the left side, the small amount of fluid and the relatively high phthalein output or concentration, with the small kidney shadow, and the fact that the kidney was not palpable on this side, while distinctly palpable on the right, made the diagnosis of insufficient kidney of the above type seem probable. One thing is evident in this case, however; that nephrectomy on the right side should not be performed without previous exploration of the left.

Case VIII. Male, age 50 years. Diagnosis: Hæmaturia from right kidney with double ureter and double pelvis; atrophic left kidney.

Following a severe blow over the region of the right kidney, sustained in a railroad accident one year previous to admission, the patient noticed blood in his urine which has continued up to the present time. Physical examination, August, 1912, shows nothing particularly abnormal. The blood pressure is normal. Neither kidney is palpable and there is no tenderness in either lumbar region. The urine is of a distinct wine color, and, on cystoscopic examination, a stream of bloody urine is seen issuing from the right ureter. Catheterization of both ureters was performed and a functional estimation made, phenolsulphonephthalein given intravenously and a collection of urine made for one-half hour.

RIGHT	LEFT
Function free and rapid.	Function slow (one-eighth amount).
Full of blood.	Clear; good color.
Microscopically negative except for red blood corpuscles.	Microscopically negative.
Urea 1.2 per cent.	Urea 1.2 per cent.
Phthalein appeared in 5 minutes; amount recovered 35 per cent.	Phthalein appeared in 5 minutes; amount recovered 4 per cent.

Pyelography with 15 per cent. collargol showed on the right side a double ureter, extending from the crest of the ilium and ending in two apparently normal pelves, rather widely separated. Injection of 7 c. c. in the left kidney produced definite pain, and pyelography showed an irregular, small, indefinite pelvis.

Estimation of the total renal function was normal, there being an excretion of 50 per cent. for one hour and ten minutes after intramuscular injection of phenolsulphonephthalein. All the above examinations were repeated three times, with practically identical findings at each examination.

It is very evident in this case that there is present on the right side, which is the source of the hæmaturia, either two separate kidneys or more probably, a large bifid kidney, which has seven-eighths of the total function. On the left there is present a kidney secreting a urine small in amount, with a urea concentration equal to that of the right kidney, microscopically and chemically normal, but with a function so low, that it is extremely improbable, that it could maintain life. Of course, it is impossible to state the exact cause of this small function, but, it seems probable, in view of the findings that this kidney belongs to the atrophic type under discussion.

The variety of kidneys described above may be divided into two general classes; in the one we recognize a small kidney secreting a normal urine, but not truly infantile except as to size, in that the histology is not normal. In the other class the diminutive kidneys are histologically normal and fall under the infantile group.

A histological study of the first two cases shows definitely the presence of pathological changes, and, while on gross in-

spection the tissue of the organ may seem normal, microscopic examination shows distinct abnormality. The changes present do not seem to be the result of secondary atrophy. Over considerable areas there is an entire absence of tubules and glomeruli; these areas being represented by fibrous tissue. In other areas, one finds perfectly normal tubules and glomeruli which could undoubtedly secrete a urine, perfectly normal in general character. The cause of the diminutive size in these two cases lacks definite explanation, although it seems probable, that the changes are the results of prenatal disturbance. In Case V, the total weight of the kidney was 40 grammes, the upper pole being the seat of a tuberculous affection, the remainder of the kidney being perfectly normal in architecture and general appearance. Microscopic examination of the remaining portion shows comparatively few changes, and the tissue might be considered distinctly normal. This kidney approaches nearest to what might be called an infantile type, in that, although diminutive in size, the renal substance itself is entirely normal, except for occasional minute changes about the glomeruli. The smallness of the kidney in this case is not the result of the tuberculous process, but the tuberculosis has occurred in a kidney, congenitally small.

The main point to be emphasized is, that such kidneys are a menace to the surgeon, when the opposite kidney is the seat of disease. Their recognition may be extremely difficult and their presence can be suspected only when functional estimations are carried out. The character of the urine from these kidneys may be normal in appearance, and even the relative urea concentration or percentage may be equal on both sides.

In one case considerable diagnostic help was obtained from the X-ray, which showed a very small shadow; less than half that of the opposite side, which, taken in conjunction with the functional findings and the character of the urine, made the diagnosis evident.

When disease is present in the diminutive kidney, it seems very improbable, that we can diagnosticate the presence of

this type of kidney with our present methods of renal diagnosis. This, however, is of no practical importance, because the removal of such a kidney, if the opposite kidney were in good condition, would not be attended with anything but beneficial results.

SUMMARY

The diagnostic points in determining the presence of a kidney of the type we are presenting may be summed up briefly as follows:

1. When the disease is present in the larger hypertrophied kidney, the total function as estimated by phenolsulphonephthalein, is decreased.

2. The function of the diseased kidney may be, and usually is, greater than the function of the supposedly healthy kidney.

3. The function of this kidney shows marked decrease, although the urea percentage and general character of the urine may be normal.

4 The amount of urine secreted is relatively small.

5. Pyelography may offer some help in showing a pelvis, which is small, as compared with its fellow on the opposite side.

6. If the individual be not too stout, it may be possible to get a shadow, showing the presence of a diminutive kidney.

The question as to the smallest amount of renal substance, compatible with active existence, is still unsettled. Many of these diminutive kidneys, are, undoubtedly capable of supplying sufficient function for life, and the pathological change present, probably not being a progressive one, the amount of kidney tissue present if sufficient for life at the time of nephrectomy, will probably prove sufficient subsequently. In other words, the amount of function present in the kidney will be maintained and will not progressively diminish.

On the other hand, it should be recognized that these kidneys do not have the inherent power of compensatory hypertrophy. Any increase in the function of such a kidney, fol-

lowing nephrectomy on the opposite side, will only result from the release of the inhibitory influence caused by the disease in that opposite kidney.

It has been shown repeatedly in previous functional studies, that the combined function of the diseased and healthy kidney before nephrectomy is frequently less than the function of the remaining healthy kidney some time after nephrectomy on the diseased side. That is, the remaining kidney, if healthy, assumes a function greater than the combined function of the diseased and healthy kidney, previous to operation. Consequently, it is perfectly feasible to expect that the function of one of these kidneys of the type that we are here considering, may be increased to some slight extent after the diseased kidney has been removed.

We shall not attempt to postulate the minimum amount of function which would justify nephrectomy. There are cases in which one could positively say that nephrectomy would be followed by disastrous results, and others in which nephrectomy may be performed with comparative safety, but there are many border line cases in which the ripest judgment and most careful study will have to be exercised.

PYONEPHROSIS TUBERCULOSA OCCLUSA

By H. A. Fowler, M. D., of Washington, D. C.

CLOSED pyonephrosis is one of the most unusual complications of renal tuberculosis. As a result of the extensive pathological changes associated with this form of kidney infection, the renal pelvis or the ureters may become completely occluded so that the secretion from the kidney no longer reaches the bladder. This process is called "autonephrectomy" and the resulting condition closed tuberculous pyonephrosis or pyonephrosis tuberculosa occlusa.

This condition is of very great surgical interest on account of its rarity as well as the great difficulty experienced in the majority of cases in making a positive diagnosis before operation. Smirnow was able to collect only twenty-four cases scattered through the literature. These he briefly abstracts in a recent paper and adds a personal observation.

In this series of collected cases it is noteworthy that not a single one was reported from this country, and only one case (Whipple) is reported in the English literature. While this complication is comparatively rare it hardly seems possible that it is as rare as these statistics would indicate. It is significant, however, that Kapsammer records only three cases in his large series of cases of renal tuberculosis operated upon, while not a single case is reported by Israel. Moreover not more than three cases have been reported by any one observer. That the diagnosis is often difficult or even impossible in some of these cases before operation is evident from the fact that in the series collected by Smirnow, the condition was recognised and accurately interpreted in only a very few cases (six or seven), previous to operation. Without the data furnished by the cystoscope and ureter catheter one had to depend upon the older clinical methods of examination for the diagnosis. It was impossible by these means to determine accurately in certain cases, which was the healthy and which the diseased

organ. When the diseased kidney was atrophic, insensitive and not palpable while the healthy one was sensitive, palpable and enlarged, the latter has been mistaken for the diseased kidney. The mistake has been made of removing the only functioning organ.

It is probably safe to say that no other condition of the kidney presents greater difficulties in the way of an accurate diagnosis than closed tuberculous pyonephrosis in certain cases. Even with the aid of the newer methods of examination these difficulties are at times insurmountable and a definite preoperative diagnosis is impossible. (Zuckerkandl's first case.) Pyonephrosis tuberculousa occlusa results from the occlusion of the pelvis of the kidney or the ureter at some point. This may occur at any point in the kidney or ureter, usually at the lower end of the ureter. The resulting anatomico-pathological condition will depend upon the number and the location of the strictures as well as upon the time when the permanent occlusion takes place. If the stricture occurs at the lower end of the ureter, the latter is generally dilated together with the renal pelvis. If at the upper end the ureter will be permeable up to the point of occlusion, but not dilated, and the renal pelvis and calices may be enormously distended. When the occlusion takes place relatively early there is generally dilatation above the stricture; if on the other hand this occurs gradually and relatively late the kidney may become completely destroyed and only remnants of the organ will be found at operation surrounded by dense fibrous tissue.

We find, therefore, that cases of pyonephrosis tuberculosa occlusa fall naturally into two main groups, depending upon the presence or absence of renal distention; first, those presenting a lumbar or abdominal tumor, and second, those in which no tumor is present and the affected organ is atrophic.

The majority of cases belong to the first group. These patients usually seek relief on account of a swelling in the lumbar region or the upper abdomen associated with marked local

pain. The size of the tumor will depend upon the distention of the kidney and its pelvis, and naturally varies widely in different cases. Exceptionally it may attain enormous proportions, in one case (Delbet) the pyonephrotic sac contained four liters, in another (Tuffier) two liters, and in a third (Krauss) one liter. Very confusing from the standpoint of diagnosis are the cases where the kidney abscess ruptures and the pus burrows down along the psoas muscle and points at a lower level. In such a case the condition may be at first mistaken for spinal disease. (Simons' first case.)

To the second group belong the cases with extensive renal destruction without distension. The kidney is gradually destroyed by cavity formation and advancing sclerotic changes with fibrous and fatty transformation. In this way the pelvis may be completely obliterated and replaced by a dense deposit of fatty tissue. The small cavities within the kidney substance are surrounded by dense fibrous tissue which completely replaces the renal perenchyma. The affected kidney is atrophic, smaller than normal and at operation is found buried in dense fibrous tissue. Zuckerkandl was the first to call attention to these cases in his paper before the German Urological Congress in 1907 in which he reported three cases. The difficulties in the way of a correct preoperative diagnosis are well illustrated in his first cases. The bladder was so extensively involved with tuberculous ulcers that it was impossible to obtain separate urines. One kidney was large, palpable and tender while the other was insensitive and not palpable. It was natural to assume that the enlarged tender kidney was the diseased one. It was only by exposing both kidneys that the real condition was revealed, that the enlarged kidney was the healthy one and had undergone compensatory hypertrophy while the other was sclerotic and pyonephrotic.

In pyonephrosis tuberculosa occlusa the pathological changes are not limited to the kidney and ureters, but the infection may extend to the surrounding tissue. This occurs directly by the rupture of the pyonephrotic sac or indirectly

by the lymph channels. In such cases the perirenal and perureteral tissues are thickened by deposits of dense fibrous and fatty tissue which obscures the anatomical landmarks and makes operative interference extremely difficult and tedious. The bladder, too, often becomes secondarily involved by direct extension and complicates the clinical picture.

As suggested by Smirnow we may divide the cases of pyonephrosis tuberculosa occlusa in three clinical groups from the standpoint of diagnosis.

1. The bladder is tuberculous. In the region of the supposedly diseased kidney a large tumor, the pyonephrotic sac, is found. The ureter on this side is impermeable. Diagnosis easy.

2. The bladder is normal. One ureter is impermeable and on this side there is a tumor in the kidney region. Diagnosis is possible from the history of the case and symptoms referable to other organs.

3. The tuberculous involvement of the bladder is far advanced. Cystoscopy is impossible. An enlarged kidney can be palpated. Diagnosis is only possible by exploratory incision. The enlarged kidney may be healthy and only hypertrophied, while the other kidney is atrophic and tuberculous.

The history of our case is as follows:

In February, 1911, I was called in consultation by Dr. H. Selhausen to see a young man who it was thought had trouble with his left kidney. He gave a history of bladder trouble dating back twelve years. This began with marked painful and frequent urination. The urine contained pus and blood at that time. He was examined by Dr. George Walker of Baltimore, who found that his bladder was ulcerated and that the urine contained tubercle bacilli. He was given the usual treatment for tuberculosis of the bladder employed at that time and was advised to go to New Mexico to live. During the next five or six years he lived in Las Vegas, N. M. During that time his general condition did not improve and he returned to Washington looking and feeling badly, and with the same

urinary symptoms. Urination was so frequent that he had to wear a rubber urinal.

Two years ago he consulted Dr. Young of Baltimore. At that time the bladder capacity was only 30 c. c. Dr. Young was unable to catheterize the ureters, but suspected a left pyonephrosis and advised operation. This was refused.

His condition remained about the same until about three weeks before I saw him when he developed a fever and complained of pain in the left kidney region, extending up under the ribs. Because of the fever, pain and increasing weakness, he had been confined to the house for the last three weeks. At the time of our first visit the patient was confined to bed and complained of a pain in his left side, which was sore and tender. He looked and felt ill, his complexion was sallow, and he was thin and cadaverous. Examination showed a distinct bulging in the left loin most prominent just below the costal border in the posterior axillary line. The overlying skin was reddened. This was tender to slight pressure and distinct fluctuation could be made out. The right kidney could not be felt. A very hard small nodule could be felt in each epididymis which he stated had been present for several years. The urine was perfectly clear and free from shreds, and amber in color. His temperature was 101°.

The diagnosis of perirenal abscess was made and the patient was sent to the University Hospital. The same evening an aspirating needle was introduced and a large quantity of thick pus evacuated. The following day, under cocaine this abscess was opened and a large cavity was found extending upward superficially underneath the ribs toward the pleural cavity. This was evacuated and drained by two rubber tubes.

He improved rapidly after this operation. The fever subsided and he gained twenty pounds in weight during the next 3 months. Meanwhile the wound continued to discharge profusely despite daily irrigation. The cavity contracted down to a sinus occupied by the drainage tube, extending about five

inches upward beneath the ribs. The discharge continued very profuse.

In June, 1911, four months after the operation, it was evident that the patient was losing ground. He again developed a rise in temperature, became weaker and began losing weight. A cystoscopic examination made at the time revealed an interesting condition. The bladder was definitely contracted holding only about 90 c. c. The bladder wall was in general normal. The trigone appeared to be pulled around to the left about 45 degrees, so that the right ureteral opening was directly in the midline while the left opening was drawn far up on the left side. The right opening was large, patulous, and emitted urine at frequent intervals. The left opening was indistinct and was surrounded by a hæmorrhagic area of inflammation. There were no ulcers present and no tubercles could be seen. Nothing could be seen to escape from this ureter. A catheter was readily introduced into the left ureter and passed without difficulty to the pelvis of the kidney. Nothing was obtained through this catheter. Indigo carmine was injected, this appeared from the right ureter in nine minutes. A colored solution was then injected into the left ureter in considerable quantity to demonstrate if possible a connection between the pelvis of the left kidney and the sinus from the previous operation. No color appeared and the dressings were not subsequently discolored. It was evident from this examination that the left kidney was not functioning, and there was no demonstrable connection between the kidney pelvis and the sinus from the previous operation. There was no stricture of the left ureter. It was also evident from the patient's general condition that there was a deep focus of infection which had not been reached and which was responsible for his fever and other signs of toxæmia. It was presumed that this deep abscess was in the kidney, that the condition was one of closed pyonephrosis, but its relation to the abscess which had been opened four months before was not clear. An

exploratory operation upon the kidney was advised and accepted.

On June 2nd a lumbar incision was made. The scar tissue was pronounced, infiltrating the muscle and obscuring the anatomical landmarks. The lower pole was exposed and stripped of its thickened capsule. Over the upper pole the capsule was greatly thickened, so firm and thickened and adherent to surrounding structures that it was with difficulty separated. In the process of freeing this the finger suddenly broke through into a large abscess cavity, and pus in large quantity welled up into the wound. This cavity was rapidly enlarged, exposing an abscess cavity quite as large as one's fist. This cavity was separated from the abscess cavity, opened at the first operation, by the thickened diaphragm. It was evident that the original trouble was in the upper pole of the kidney. The abscess had made its way through the diaphragm and involved the pleural cavity in a tuberculous empyema. It was the abscess in the later situation which had pointed below the costal margin and was opened at the first operation.

The remnants of renal parenchyma at the lower pole were removed by merely twisting off with a pair of clamps. There was very little bleeding. The pelvis and ureter were not identified and were not searched for on account of soiling the wound. Rubber drains were used in the separate cavities. Partial closure of lumbar incision with gauze packing about drains.

Hæmorrhage during the operation was not abundant and was easily controlled. He reacted well but was very weak and the pulse was very rapid. On the third day after the operation the bowels were opened with a laxative. A fæcal fistula formed and there was profuse discharge of fæces through the wound. Careful examination showed that the fistula had formed at the site of the abscess in the upper pole. His condition grew worse, the abdomen was tender, there was muscular rigidity, the temperature was subnormal and the pulse rate

increased. In the course of the next few days the tenderness and rigidity disappeared, but his condition continued desperate. The fæcal fistula continued to discharge, while the drainage of pus was profuse. The remaining kidney continued active. He gradually grew weaker and died ten days after the operation. No autopsy was permitted.

There are several interesting features in the case here reported.

The history of the case covers a period of over twelve years. The first symptoms complained of were referable to the bladder, they were frequency, urgency and tenesmus. The lesion in the kidney had unquestionably existed for some time without giving rise to any localizing symptoms. It was only when the bladder became involved in a descending infection that symptoms were produced that attracted attention and forced the patient to consult a physician. At this time examination showed a marked ulcerative cystitis. The urine contained quantities of pus and blood and tubercle bacilli were found. When I first saw him, twelve years later, the urine was *perfectly clear*. Cystoscopy showed a practically healthy bladder mucosa, but a much reduced bladder capacity.

The absence of the marked ulcerative cystitis which was present at the first examination was due unquestionably to the blocking of the communication between the infected kidney and bladder. With the flow of infected urine from the kidney over the bladder mucosa cut off, the vesical lesions cleared up and entirely disappeared. This is a very interesting observation and shows how the bladder tuberculosis sometimes heals when the primary source of the infection has been closed off.

Here autonephrectomy had accomplished, so far as the bladder was concerned, what surgical nephrectomy at times accomplishes in similar cases. Our case illustrates very well the fact that autonephrectomy can not be considered a curative process. The subsequent history of the patient warns us against trusting to the natural cure of renal tuberculosis by autonephrectomy.

Another interesting feature is the rupture of the abscess in the upper pole through the diaphragm, producing a tuberculous empyema. It was the pus in the pleural cavity gravitating to the lowest point and producing a fluctuating swelling at the costal border that first attracted attention to the region of the kidney. I have not met a similar complication among the cases of closed pyonephrosis reported in the literature. The position of the abscess in the upper pole directly beneath the diaphragm, and the dense fibrous tissue surrounding the whole kidney and closely adherent to the contiguous structures probably account for the pus taking this course. This dense scar tissue doubtless prevented the pus from gravitating downward along the psoas muscle and ureter outward toward the surface. At the first operation it was the abscess in the pleural cavity that was opened and drained. The primary focus in the kidney remained closed until the second operation.

A further interesting feature in our case is the fæcal fistula which formed when the bowels were opened for the first time following the operation. This complication following operation for pyonephrosis and perirenal abscess has been noted, but is, fortunately, very rare. The fistula forms independent of any injury to the peritonæum or bowel. I am certain that in our case no injury was done to either the peritonæum or bowel. The discharge of bowel contents through the wound did not occur until after a laxative had been given. The most probable explanation of this complication in our case would appear to be that the peritonæum overlying the abscess in the upper pole of the kidney became involved and a loop of bowel became adherent at this point. When the support was removed by drainage of the abscess, the peritonæum and bowel wall gave way before the pressure.

RENAL FUNCTION

By B. S. Barringer, M. D., of New York City

FROM 12½ to 25 per cent. of all operative deaths following nephrectomy are due to renal insufficiency—to an improper estimation of the reserve force of the remaining kidney. In a certain number of cases the kidney function as measured by our present tests and particularly phenolsulphonephthalein, varies with the destruction of the kidney tissue. The higher the output of phthalein the better is the kidney able to withstand nephrectomy of its fellow. In certain other cases there occurs what might be termed "sports" in which a kidney of normal or practically normal function as estimated by phthalein, by urea, or by any other known test, utterly refuses to bear out these tests and the patient dies anuric. As far as one can judge the deaths in this latter class exceed those in the former. The following cases are instances: Cabot[1] reports a case in which the normal kidney excreted 36 per cent. of phthalein in an hour. Its diseased fellow kidney was removed and the patient died of renal insufficiency. The kidney that failed was normal and hypertrophied. Asakura[2] in 70 nephrectomies had four operative deaths; one of which was due to anuria. According to indigo-carmine excretion and the cystoscopy the kidney that failed was considered to be normal in function. Some years ago before the days of phthalein I saw a case that could not be cystoscoped because of an irritable urethra. A nephrectomy on one side and decapsulation on the other was performed. The operation was unduly long. Neither kidney showed any gross abnormality. The patient died anuric, yet neither kidney was removed and operations which are often done for the very relief of anuria had been performed. I believe that neither the progressively decreasing output of phthalein suggested by Geraghty, nor any other known test, will give any index to the occurrence of these cases. A modified reverse of Beer's

and Alessandri's conclusions as to the value of phloridzin "that while it is of value when positive, it is of no value when negative," can be said of all renal tests, and especially of phthalein. That is: *Positive and sufficient phthalein excretion does not preclude the possibility of death from renal failure.*

There are four other points which I wish briefly to consider in estimating renal function:

First: Variation of Phthalein in Normal Cases.

In twenty-five cases (nearly all intravenous phthalein) the average time of collection of phthalein after its appearance was about 15 minutes. In almost one-half of these cases the time of collection was but 5 minutes. Some variations of excretion are due to this short period of collection. I believe, however, that if urine runs from either catheter freely a diagnosis can be made in most cases in such a short period. If there is one thing more than any other which has brought cystoscopy into disrepute it is the old time, nerve-racking sessions. Slight inaccuracies of diagnosis are better than leaving the impression that cystoscopy is a major operation. Likewise with very rare exceptions cystoscopy should be a "one step procedure."

In these twenty-five cases which from the phthalein and urea excretion, the microscopical, and other examinations, I have every reason to believe were normal, the shortest time of appearance of red after intravenous injection was three minutes; the longest 12 minutes. The greatest variations in the excretion of the two were in proportion of 2 to 1, on one side an excretion of 10 per cent. and the other 21 per cent.

As a fair guide to normal excretion after intravenous injection, Keyes gives the terse formula "1 per cent. in 1 minute for 1 kidney." In one of my cases 30 per cent. was excreted in 8 minutes. The lowest excretion was 10 per cent in 15 minutes. In one ureter catheterism case in which the urine flowed freely there was no red excreted for 20 minutes after an intramuscular injection. In line with this instrumental inhibition

I have seen a case of bilateral nephritis with one kidney as good as the other in which for a half hour no urine at all came from one kidney, while urine dropped constantly from its fellow. In most cases after intramuscular and intravenous injection the greater part of phthalein comes down in the first hour. In entirely normal cases this may be reversed. In a case of unilateral kidney bleeding due to hæmophilia 9½ per cent. came down in the first hour and 46½ per cent. in the second. The ratio of red excretion in a given time respectively after intravenous and intramuscular injection is usually about 2 to 1.

Second: The Individual "Dead Line."

Every death from suppression of urine following a nephrectomy is said to be due to the inability of the remaining kidney to sustain life. The immediate cause of death in such a case is the operation; the anæsthetic, the surgeon's manipulations, or both. Because of the varying technical skill of different surgeons, any general measure of functional capacity must be modified to accord with the surgeon that is to operate. In other words, if one surgeon places his "dead line" at a certain percentage of excretion this "dead line" may not at all apply to a second surgeon whose mode of operation may vary considerably from that of the first. To establish such a personal "dead line," such a low limit of excretion of either normal or introduced substances, one must have had at least one patient die of renal insufficiency. This death will establish a low limit of excretion which if approached in any other case will preclude nephrectomy. It is possible that the low limit of excretion of both kidneys, as observed in cases of prostatectomy, might apply to a single kidney in cases in which nephrectomy is the operation.

In fifty normal and abnormal kidney cases in which phthalein was used I have learned nothing of the renal function and of the practical value of phthalein in estimating the renal function. In none of these cases was there enough disease to seriously impair the function of the remaining kidney.

In other words, in the fifty consecutive cases one kidney never varied seriously from normal function. This indicates how difficult it is to get enough cases upon which to base any deductions as to the value of any renal function tests.

Third: Urea and Phthalein.

The estimate of the urea percentage and the urea volume (I am not sure which is of more value) is a necessary and valuable adjunct to the information given by phthalein, not so much to tell us of renal function, for the urea excretion from one kidney tells us nothing of its function, but as an aid to diagnosis. Not unfrequently when the phthalein output becomes inadequate as in some cases cited above, the urea estimate helps considerably.

Fourth: Value of Estimating the Total Destruction of the Kidney.

Five years ago in speaking of the urea excretion I said that with the total urea excretion from the diseased kidney less that one-fourth of that excreted by its fellow, such a kidney is practically destroyed. This estimation was arrived at by examining the reports of a number of cases in which nephrectomy had been done. The value of this seems to be twofold: First, it is of worth to know if a kidney is practically useless, and has practically very little or no tissue left, because then a surgeon will have less compunction about removing it if the diagnosis of the cause of the disease is in question. Second, it would seem if one kidney were entirely destroyed and if the other kidney which had taken up the total excretory work, had hypertrophied, this case would be less likely to be one of the class of "sports" spoken of above. This class of cases should be furthest removed from the possibility of death from renal failure. In making this 4 to 1 equation, either urea percentage, urea volume or phthalein may be used. I believe, however, that the urea volume gives more accurate results than either of the others.

Summary: Phthalein is the best single drug for the estimation of the kidney function. The amount of phthalein ex-

creted varies with the destruction of kidney tissue and generally, but not always, with the functional capacity of the kidneys. Because of the variations in its excretion phthalein should be used in conjunction with the urea excretion, not to estimate the kidney function directly, but to estimate the comparative work of two kidneys. If the urea volume of the diseased kidney is less than one-fourth of that excreted by its fellow that kidney is practically destroyed. In certain cases no known test of renal function can foretell the death from anuria that follows operation.

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DISCUSSION

Dr. Robert H. Greene, of New York: Some two years ago I carried on a series of tests at the City Hospital in which I compared the value of phenolsulphonephthalein and phloridzin, using both preparations on the same individuals. I reported those cases rather briefly in a discussion before this association two years ago. The result of my experiments at that time, which were conclusive enough to suit me, was that of the two preparations the phloridzin was very much superior to the phthalein. One case I remember very distinctly. This man was dying of nephritis, and as the condition of his kidneys gradually grew worse from the phthalein test they showed improvement, until the day before he died, according to the phthalein test they had improved to a very marked degree from the condition they were in a week or so previously, while his clinical condition and his state as shown by the phloridzin test were in accord. I regard the phthalein test as having considerable value but in a general way the introducers of it and some of those who have used it considerably claim too much for it, have not used it sufficiently in comparison with other tests on the same individuals, and I believe it will eventually go the way of other tests and preparations for which too much have been claimed. One of my associates, Dr. Shapira, has continued in the last two years to carry on in a large number of cases the experiments, the results of which were reported by me two years ago and his recent work has only tended to confirm the conclusions arrived at at that time.

In almost all color tests I find that one simple thing, which is of a good deal of practical importance, is the amount of water that the patient consumes. It is my experience that if the patient drinks a good deal of water it interferes considerably with all the color tests. To repeat, my experience has convinced me that of the two tests phloridzin is still much superior to phthalein.

Dr. Louis E. Schmidt, of Chicago: I am in perfect accord with what Dr. Geraghty says, but we must admit that frequently we will find that these phthalein figures vary. On the other hand, there are often times when we are not in a position to examine the patient in detail on account of unusual symptoms, severe hæmorrhage, pain or infection, and we are obliged to operate on the diseased side. The point I wish to make is this, that under the circumstances if we recognize the existing hyper-

trophy on the diseased side at the time of operation our operative measures must be palliative in character.

Dr. Hugh Cabot, of Boston: Several years ago, before the days of the phthalein test, I saw a case of the type referred to by Dr. Geraghty, and was unable at that time to draw correct conclusions. The patient had obvious kidney tuberculosis, but the bladder showed such a confusing picture as to make it impossible to decide which side was diseased. Both ureters were catheterized. There was evidence of an inflammatory process in both kidneys. The kidney function on one side was normal and on the other was very low. I jumped to the conclusion that the side upon which the function was low must be the tuberculous side. That kidney was cut down upon, and proved to be one of these kidneys such as Dr. Geraghty describes, with a very mild degree of pyelitis, the tuberculosis being in the kidney which was doing most of the work.

Since that time there have been found at the Massachusetts General Hospital three cases to my knowledge, and I think perhaps others, with these small but in other respects normal kidneys.

There was one point raised—I am not clear that I understood it—in regard to a comparatively depressed kidney function being evidence of bilateral disease. It has been my experience that in the presence of severe renal tuberculosis upon one side the total function was frequently comparatively low; that is, in the neighborhood of 30 per cent., with a perfectly sound kidney on the other side, the total function being depressed in proportion to the severity of the general process and not in proportion to the amount of involvement of kidney tissue. I should not be inclined to agree with Dr. Geraghty that a moderate depression of kidney function was evidence of bilateral kidney disease.

I am unable to agree with the views of Dr. Barringer as to the value of the phthalein test as compared with the urea excretion. It has seemed to me that the urea excretion was an excessively unsound guide, and I had supposed it had been entirely or largely abandoned. It depends on so many factors over which we have so little control—questions of diet, questions of muscular activity—that it has seemed to me pushed entirely into the shade by the estimations of nitrogen. The test recently introduced for incoagulable nitrogen by Follin has put that upon such a basis that is is now an accessible and executable test, which it has not been before, and I believe in dealing with these questions of nitrogen excretion it will supplant the estimation of urea.

I think what Dr. Greene said was substantially what he said two or

three years ago, and seems to me wholly at variance with the accepted belief of all sound observers. I cannot believe that phloridzin is now properly regarded as of any considerable value. It obviously does not show the work of damaged kidneys. It may be entirely suppressed in the presence of very good kidneys. On the other hand, the more work done with the phthalein test, the more accurate it appears to be. The occasional cases spoken of as "sports" by Dr. Barringer—and I admit that the whole question of renal surgery is a sporting proposition—these accidents are rare, and it seems to me with increasing experience that it is the most valuable test at our disposal.

Dr. Henry H. Morton, of Brooklyn: I was very much interested in hearing Dr. Fowler's paper on pyonephrosis tuberculosa occlusa, because I had such a case a few years ago. I was surprised to hear that it is such a rare condition. It was the only one I had happened to come across and I supposed it was commoner in practice. The difficulties of diagnosis were very great. We first thought it was a case of renal calculus, because the pain was located over his kidney and he had frequent attacks which resembled renal colic. The pain was so severe that he became a morphine habitué. Dr. Edgerton saw the case before he came into my hands.

On cystoscopy and ureteral catheterization the catheter was arrested a short distance after entering the ureter, perhaps half way up, but the X-ray showed no stone. On cutting down I found that the kidney, instead of being enlarged and filled up with pus, was very small, atrophied, the parenchyma destroyed and the organ was converted into nothing but a small pocket of fibrous tissue, perhaps half the size of the kidney, filled up with a little purulent urine. Nephrectomy was done, and the patient made a smooth recovery and lived for some years afterwards.

I am rather surprised that more use is not made of the indigo-carmine test in determining the relative functional capacity of the two kidneys. It seems to me that it is a great deal easier to use where you wish to compare the function of the right and left kidneys than the phthalein test. With indigo-carmine you can get results in a few minutes, you do not have to leave the catheter in situ for an hour or two hours in order to get the whole return. I have been using it as a routine in the last two years. I have examined perhaps twenty-five or fifty cases, and in all I have never known it to fail in showing disease of one side when present. The idea is that in the diseased side the excretion of the indigo-carmine will be delayed. Injected hypodermically normally it will appear in five

to eight, possibly ten minutes in the urine. The normal appearance of indigo-carmine on one side in five to ten minutes, and a delayed excretion of from twenty to thirty minutes on the other side would indicate disease of that side. As I say, it is a very convenient thing to use, it does not require anything but the observation of the opening of the ureter, or perhaps ureter catheterization, although that is not necessary. It seems to me exceedingly reliable, and in the cases in which I have used it I have never known it to fail to show disease of one side where it existed.

Dr. John R. Caulk, of St. Louis: Amidst this seeming turmoil of functional tests I should like to insert a few observations. Last week Dr. Davis and I in St. Louis reported in the neighborhood of 200 cases of various types of renal disease, unilateral and bilateral, and obstructions at the vesical neck, in which we had utilized the phthalein in conjunction with other methods, urea, nitrogen, and in many cases phloridzin, and almost invariably our results with phthalein showed us the true nature of the renal disease. There were very few exceptions.

With reference to the assumption by one kidney of the function of the two, as Dr. Geraghty cited, I should like to mention one case which I had of unilateral renal tuberculosis in a young woman, who, before operation had very little deficiency on the abnormal side because, as found at operation, she had a very slight renal process. The normal side showed about 38 per cent. for one hour. Following operation she did nicely, and three weeks after operation her functional test with phthalein showed a delay of time of appearance, and only 8 per cent. excretion for one hour, at half hour intervals, although the patient at the time was in perfectly good clinical condition. Three months later we did another functional test on this patient, and found the time of appearance to be four and a half minutes instead of thirteen minutes, and that the total excretion for two half hour periods was 48 per cent., which was greater than that before operation, showing the compensatory hypertrophy, which took time to develop, and the depression immediately after operation was evidently due to inability to compensate temporarily, although the kidney from clinical evidence was in good shape, as it proved to be later.

Dr. Francis R. Hagner, of Washington: I have not had a case such as Dr. Fowler has spoken of. But I did have an interesting case of perinephritic abscess with the development of fæcal fistula. This man has a history of furunculosis, and developed a perinephritic abscess, from

which a pure culture of staphylococcus aureus was obtained, and two weeks later he developed a fæcal fistula. Of course, in that the colon bacillus was found, showing unquestionably that it was not from an intestinal infection that the perinephritic abscess had developed.

I think Dr. Geraghty's work has made us more conservative in kidney surgery, and believe that is a very valuable thing. I recently had a case that bears that out very well, in a poorly nourished man with a large number of calculi in a large pus kidney on one side. On the opposite side there was a little pus, and the output from that side in an hour was about 9 per cent. The man was very anæmic and in poor general condition. There was no urine coming from the kidney containing the calculi, and the assumption was that the thing to do was to take that out, but on account of his bad condition and the low output I decided on a palliative operation. I opened the kidney, took out eighteen stones and evacuated the pus. I then drained the kidney, and the patient has gone on to what I think an excellent recovery. He still has pus in his urine, and there is still pus discharging from the kidney, but nothing like it was before. The output has gone from 9 to 26 per cent. He still has a sinus there and I propose to go in later and take the kidney out intracapsularly. Later I hope to report some cases of secondary intracapsular operations.

Dr. J. Dellinger Barney, of Boston: In view of Dr. Fowler's statement as to the rarity of these kidneys, it may be worth while to mention a case we had at the Massachusetts General Hospital. It was that of a young boy with marked bladder symptoms of many years' duration, pain, frequency and urgency, and also a contracted bladder with pus and blood in the urine. There was no definite history pointing to any disease of the kidney in the past. He was cystoscoped repeatedly, and we could make out a contracted bladder, ulcerated here and there, with areas of granulation. The ureters were not definitely seen. Finally under ether it was made out that the trigonum was very much distorted, to such an extent that the right ureter was in the median line, and so dilated that in certain positions of the cystoscope one could look straight up the ureter, as if looking into the mouth of a diverticulum. Repeated search failed to reveal the orifice of the left ureter. Guinea pigs were repeatedly inoculated, and were always negative to tuberculosis. We finally opened the bladder and found the conditions seen with the cystoscope, but could not find the left ureter orifice even then. The functional test was somewhat low on the right side, so we inserted a very good sized soft rubber

catheter up the ureter and drained the right kidney for several days, without discomfort to the patient, and the functional test increased very markedly. At the time of opening his bladder the ureters were explored by opening the peritoneal cavity. On the left there was a thick, stiff ureter, which seemed to confirm our ideas of tuberculosis, and on the right a soft, markedly dilated ureter. After a sufficient length of time for the functional test on the right side to become satisfactory the left kidney was cut down upon and found to be a small fibrous affair, somewhat adherent, but not difficult to take out, and on splitting it it was found to be practically entirely caseous material, with no renal substance left. The pathologist's report was tuberculosis.

In connection with the diagnosis of these cases, of which this is a sample of how difficult they sometimes are, we have an X-ray at the hospital of a kidney of this type which was taken before operation, and which shows the kidney and practically the whole ureter a solid mass of calcareous deposit, which suggests that possibly the X-ray might be of more value than we would suspect.

In regard to Dr. Morton's statement as to the value of indigo-carmine, I would like to call attention to the fact that in an alkaline urine with pus the color does not show up at all, or, if so, only slightly.

Dr. Hugh H. Young, of Baltimore: I have been greatly interested in Dr. Fowler's paper, which certainly brings up a very interesting and valuable point in the pathology of tuberculosis of the kidney. Several years ago I had a case similar to this, in which there was a stricture at the lower end of the ureter, the bladder being quite normal, showing no evidence of tuberculosis; as a matter of fact, no tubercle bacilli could be found in the urine, which was fairly clear, and, although the prostate and seminal vesicles suggested that there had been an old tuberculous process there, we could not get bacilli. He had a very large palpable kidney. It was very evident that he had a pyonephrosis on the right side, and in cutting down upon it I found an extremely large ureter, which at once suggested tuberculosis. It was almost as large as the small intestine, so I followed it down toward the bladder juncture and there found an extremely tight stricture of the ureter, the ureter being bound up with the seminal vesicle. It seemed to me in this case that the onset and the growth of the process had come from the seminal vesicle, and a further set of researches which I made in Guyon's laboratory in Paris, where there are a tremendous number of specimens, showed that there were a number of cases where the disease had extended from the seminal

vesicle and produced an occluding stricture of the ureter with a dilatation above. I think Baumgarten's idea, which is that the tubercle bacillus cannot ascend against the urinary stream, probably has some force, particularly in those cases where the infection has come from the seminal vesicle and has traveled into the ureter and up into the kidney from without from an old tuberculous infection.

Dr. Geraghty's report was very interesting. I have seen one or two cases of prostatic hypertrophy where there has been a fatal result, in which at autopsy we found an atrophic kidney of that size, evidently one of these small infantile kidneys, with an infection on the other side, and I think these infantile kidneys will have to be given more attention in renal surgery.

In the two cases of which he speaks the one in which we found tuberculosis in the upper end of an infantile kidney, was extremely interesting pathologically. The other case, in which we discovered clinically the same thing, except that the infantile kidney was the healthy one, is of great interest, because we fear the patient will never get in condition to withstand nephrectomy on the side which is tuberculous.

In regard to the use of the phthalein test, perhaps it is hardly permissible for us to report again our sublime belief in the efficacy of it. The more we use it, the more definite and reliable we find it. We have found as internes change that for a period there is always a time when you get inaccurate estimations, and occasionally we are led to operate where we should not, but with the increased experience of these men and the knowledge that it is important to have a very free outflow of urine—the knowledge that the intravenous phthalein is inaccurate because the amount of urine you get is so small that a drop or two will make a big difference in the percentage—all of those things have made it possible to avoid errors in its use. Certainly after a very careful comparative study with indigo-carmine, phloridzin, and other tests, it seems to us far the simplest, the most accurate, and about the only test by which you can get a quantitative analysis, besides being the quickest of all, and we feel that without it we should be absolutely at sea.

Dr. Eugene Fuller, of New York: I wish to call attention to a case where there occurred occlusion, or nearly complete occlusion, of the ureter from disease of the seminal vesicles. It was in a man I saw about a year ago who was running a fever, with marked pyelitis on one side. By draining the vesicle his pyelitis entirely disappeared—exactly as in the case Dr. Young mentioned.

Dr. Charles H. Chetwood, of New York: The question of functional renal diagnosis has been discussed so often and over such a long period that it seems to me we have arrived at more or less of a consensus of opinion, with a few dissenting voices, and that is that the phenolsulphonephthalein test is the best of all functional renal methods of diagnosis, and that the urea volume test has a certain amount of relative value. The employment of both of these methods, together with the clinical symptoms, will generally enable us to make a satisfactory diagnosis.

The point brought out by Dr. Geraghty is very interesting, and whether we can agree with him or not, I am sure that most of us will go home, I know I will, and when we meet a case of a diseased kidney giving a better functional result than the one on the opposite side, we will be inclined to consider this point he has raised before proceeding.

Dr. Edward Martin, of Philadelphia: I think every one who has tried it finds the phthalein test more convenient and simpler in execution than any other. For instance, one of our instructors who believed in the indigo-carmine test, so hypnotized my resident that he submitted to comparative injections. He limped for a day after the phthalein test, and was in bed three days after the indigo-carmine.

Our attention has been concentrated on the value of this test in nephrectomy. It is of the highest service in general surgery. With us all patients have been routinely tested before operation and we have thereby prevented at least one operative mortality in a patient who because of the evidences of renal insufficiency, as shown by the phthalein test, was refused operation, and who died of renal insufficiency within two days. In this instance the usual urinary examination showed no signs of kidney failure. I had what Dr. Barringer calls a "sport," the patient operated on for gall stones after an entirely satisfactory phthalein test, developed urinary suppression but ultimately recovered.

Since we are often compelled to operate even when the renal function is unsatisfactory, when the phthalein test is unsatisfactory, we give nitrous oxide.

Dr. Edward L. Keyes, Jr., of New York: I should like to say one word in reference to my belief in the phthalein test. I think it is well for us all to line up. I believe in it fully. I think it better than urea, but I think that the difficulty of doing ureter catheterization and drawing conclusions from it is the lack of infallability of the man behind the ureter catheter, and for that reason I think that it is wise to depend

chiefly upon the phthalein and to add to that a very intimate investigation of the ordinary microscopical constituents of the urine, and also of the urea percentage and urea volume. I think with Dr. Barringer that the urea volume is of considerable value. I cannot say that I consider it as valuable as the phthalein test. But I think that the great difficulty with the urea volume is with the volume. Any volumetric test is dangerous, inasmuch as it implies the necessity of getting all the urea. The danger of inaccurate volumetric estimations with phthalein, it seems to me, are very considerably less than with the urea.

Dr. Geraghty: The case reported by Dr. Barringer of a man dying of renal insufficiency after nephrectomy, but with an apparently normal, hypertrophied kidney on the opposite side, and proved to be normal by autopsy, is indeed most interesting. I feel, however, that it requires a great deal of persuasion to convince one that in such a case death was really due to renal insufficiency. In operations which are followed by severe shock, a small urinary secretion, or even anuria may occur. Death in these cases, of course, should not be attributed to renal insufficiency.

In answer to the question of Dr. Cabot, I think a definitely reduced total renal function, as estimated by phthalein, means, as a rule, a bilateral lesion. A patient with a unilateral tuberculosis may have a reduced total function, but in many of these cases the reduction in function on the apparently normal side is due to a secondary nephritis which generally disappears on the removal of the diseased kidney.

At the present time, we are employing two types of tests; the phthalein for estimation of the excretory power of the kidneys, and cryoscopy or blood urea (Marshall's method) as tests of retention. The tests of retention reveal the presence of cumulative phenomena and should always be used when the phthalein excretion is low. From our experience, it would seem probable that the blood urea will give an earlier indication of the occurrence of cumulative phenomena than cryoscopy. Indigo-carmine is undoubtedly a valuable test if you are satisfied with the amount of information you can get from chromo-cystoscopy.

Dr. Fowler: I am very glad to hear the cases reported by Dr. Morton and Dr. Barney. I feel quite certain that these cases of closed tuberculous pyonephrosis are not nearly as uncommon as we would be led to suppose by the literature, but the fact remains that very few cases have been reported. The excuse for reporting my case was the unique symptoms and complications which it presented. In that group of cases with renal distention diagnosis is certainly easy in the great majority of cases.

The mere presence of a tumor leads one to suspect the kidney, and with the application of our newer methods of examination the location of the lesion in the kidney can be demonstrated in the majority of cases. But it is in just such cases as Dr. Barney reported and the three cases reported by Zuckerkandl that the diagnosis is at times extremely difficult, particularly where the tuberculous process in the bladder is extensive and precludes the possibility of obtaining the separate urines from the kidneys.

I did not in my paper touch upon the etiology, but the points brought out by Drs. Fuller and Young are very interesting, as emphasizing the fact that the etiological factor is always a stricture, and that the stricture may be due to descending infection from the kidney, or a tuberculous process ascending, invading the seminal vesicles and producing occlusion of the ureter.

In connection with renal distention I want to mention just briefly a recent experience. A patient came into the out patient clinic with a large tumor in the left side presenting below the costal border. There was tympany in front, so we suspected the kidney. We got the patient on the table, cystoscoped him and introduced a ureter catheter. The catheter passed perhaps half way up the ureter, and purulent urine began to flow. After flowing for a considerable time this ceased, and then the catheter was advanced up the ureter further, and the flow began again. At the end of three hours 2200 c. c. of purulent urine was obtained, and the distention had completely disappeared. This patient came back the following day. The distention had recurred, although not as great as at the first time. It shows how with our ureter catheter we are able sometimes to make the diagnosis in these tumors presenting in the upper left quadrant. So far this patient has refused any operative interference.

Dr. Barringer: I simply wish to say how entirely I agree with Dr. Cabot's views as to the estimation of renal function. I tried to say in my paper that phthalein was the best test we know of. Also that urea excretion alone is worthless in estimating the renal function. I do believe, however, that the urea excretion is of value in the diagnosis of comparative destruction of the kidneys, and should be always used in conjunction with the phthalein, and so indirectly in estimating the renal function.

THE APPROACH TO THE URETER

By Edward Martin, M. D., of Philadelphia, Pa.

THE ureter, in addition to its upper expansion, the renal pelvis, exhibits two fusiform dilatations and three points of narrowing. The narrowings are placed; at about the level of the lower border of the kidney; at the point where the ureter crosses the bifurcation of the iliac artery, and at the point where the ureter enters the bladder wall. The dilatations lie between these points, nor can they be regarded as reservoirs, since the peristaltic wave which jets the urine into the bladder completely empties the canal with each impulse. That with abnormal intravesical tension they may act as checks to back pressure is suggested by the fact that a dilatation incident to intravesical pressure may abruptly stop at one or the other of the points of narrowing.

These points of physiological narrowing are of surgical importance because they represent the common seats of calculus lodgment, it being usually for the removal of stones that the ureter must be exposed and opened.

It is to be noted that the pelvic expansion of the ureter varies greatly in size, shape, and its relation to the kidney; indeed the pelvis may be intrarenal.

The flattened tubular portion of the ureter cannot readily be identified by palpation either through the peritonæum or by the approach behind this membrane. Its identification, unless the surgeon be guided by the presence of a stone, or of a periureteral infiltration, is by the sense of sight. In thin persons its position is rather definitely marked by a cylindrical investment of fat quite comparable to the fibrofatty envelope of the kidney. At its mid or lower abdominal course it is crossed at an acute angle by the spermatic vessels lying anterior to it and contributing to its blood supply. If the peritonæum be stripped forward from behind the ureter usually

comes with it. This is not the case when a dissection is made in the reverse direction.

Its vascular supply is so free from the renal, spermatic and inferior vesical that there is little danger of sloughing even though it be subject to considerable traction and manipulation. Not infrequently its veins, particularly those communicating with the spermatics exhibit varicosities and thrombi, similar to those commonly found in the pampiniform plexus. Such conditions may well explain those cases exhibiting symptoms of calculus with X-ray findings, which are shown by operation to be free from stone.

Its lymphatics in part ascend to the perirenal tissue and the renal cortex, thus explaining infections in these regions incident to foci in the bladder or ureter.

The guide to the ureter in its renal expansion is the kidney, which upon being freed of its fatty capsule posteriorly and drawn downward, or better, delivered from the parietal wound, gives free access for surgical procedure.

Across the bulge of the psoas muscle the ureter passes obliquely downward. In the upper portion of its course, near the position of the first narrowing, the vertebral body marks the inner possible limit, the external border of the psoas the outer. Between these two points, separated by a distance of about an inch, the ureter must lie.

At the pelvic brim the ureter crosses the bifurcation of the iliac artery or less than half an inch above it and dips sharply downward and backward into the pelvis corresponding to the course of the internal iliac artery. The post vesical portion, though having a perfectly distinct anatomical position clearly indicated by the crossing of the vas, and the seminal vesicle, is surrounded by veins so large and numerous as to make direct approach troublesome.

Since the ureters may be anomalous not only in number, but in length and in position, it is needful before proceeding to expose them by operation to be assured of their position in each individual case by means of either collargol in-

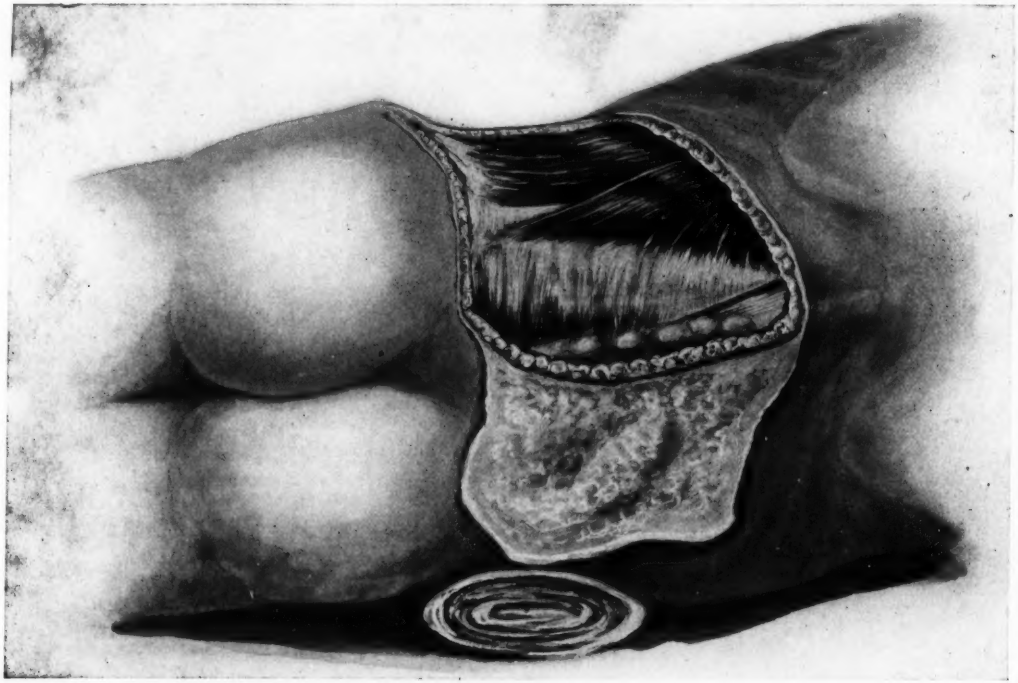


PLATE XI.—Presented by Dr. Edward Martin

Patient in right lateral position, with pad under the loin. Flap of skin and superficial fascia turned back exposing muscles of the costo-vertebro-pelvic triangle. Note the origin of the oblique fibres of the latissimus dorsi from the lumbar fascia; also the almost vertical direction of the muscle fibres of the external abdominal oblique. The non-muscular triangle of Petit offers a ready approach to the renal fossa without severing muscle fibres.

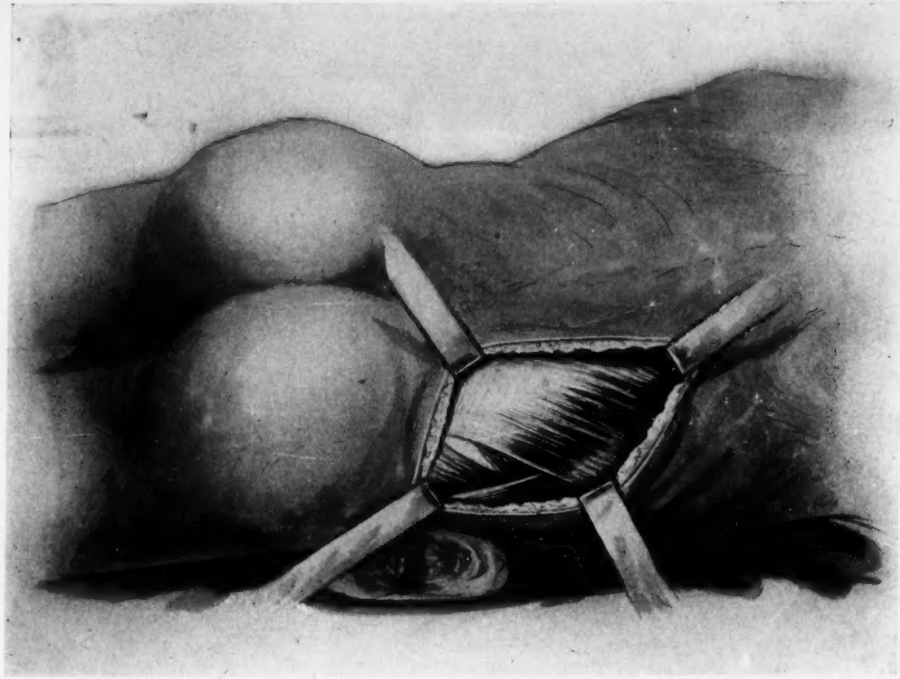


PLATE XI A.—Presented by Dr. Edward Martin

Patient in the right lateral position with pad under the loin. The incision is carried from the 11th rib down to the iliac crest along the outer border of the erector spinae muscle, and is from 5 to 7 inches long. The exposure of all muscles involved in the dorsal approach to the kidney is illustrated. The lateral border of the latissimus dorsi can be retracted medianward. The internal abdominal oblique is split in the direction of its muscle fibres, while the dorso-lateral border of the external abdominal oblique is retracted lateralward. The dissection depicts the anatomical lines of cleavage of the muscles in the loin region, through which the approach to the kidney and ureter takes place.

takes place.

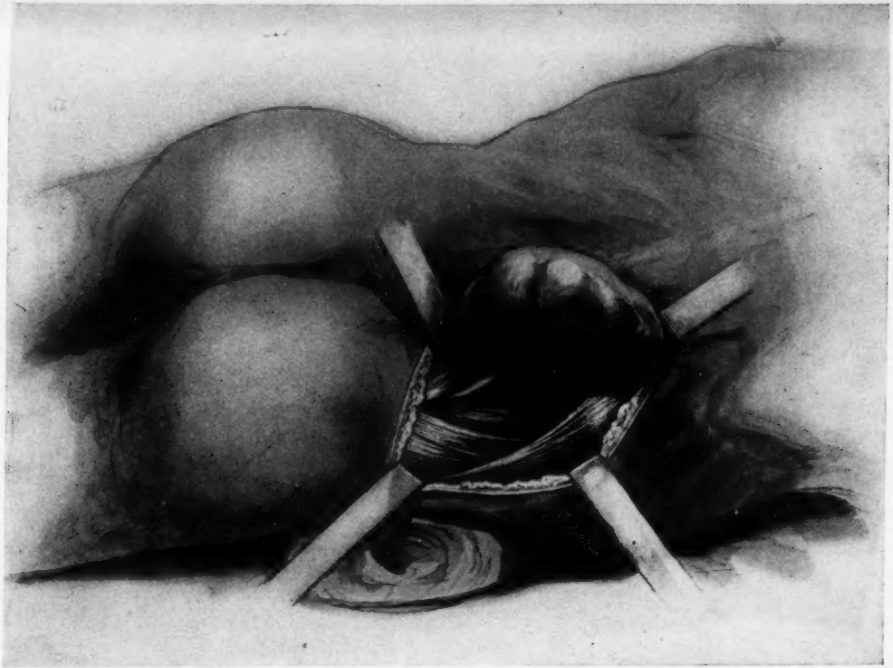


PLATE XII.—Presented by DR. EDWARD MARTIN

Patient in the right lateral position with a pad under the loin. The right kidney is delivered on the dorsal body surface. Note the free access to the kidney fossa by this vertical incision, whic is invariable longer than the vertical length of the kidney. The upper abdominal portion of the ureter is also easily accessible. The approach is through a fascio-aponeurotic line with separation of the muscle forming the costo-vertebro-iliac triangle in the direction of the anatomical lines of cleavage. The 12th thoracic and ilio-inguinal and ilio-hypogastric nerves appear in the wound and are readily preserved. Incision cuts through the posterior common aponeurosis of the three abdominal sheath muscles.

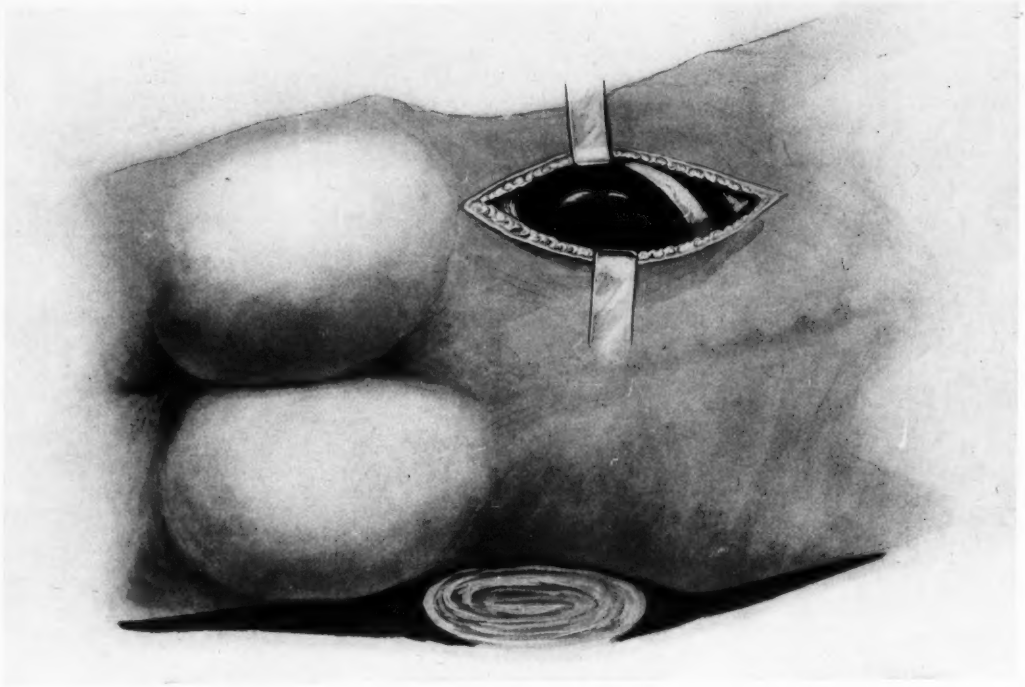


PLATE XIII.—Presented by Dr. Edward Martin

The incision is carried down to the renal capsule with retraction of the muscles. Note the relation of the 12th rib to the upper pole of the kidney. The exposure is facilitated by separation of all muscle and fascial attachments to this rib, allowing ready retraction of this structure upward and outward.

jections or the introduction of a shadow-giving catheter and the taking of X-rays.

It happens not infrequently that the catheter may fail to pass in the absence of any mechanical obstruction. A cause of this failure is incident to a laxity in its pelvic portion, so loosely secured by its fibrofatty investment that the catheter pushes the tube before it instead of following the curve of its course, producing a kink which absolutely stops the further introduction of the instrument; such a blocking will occur at a point between two and three inches from the vesical orifice of the ureter. The catheter may stop because it fails to take the sharp curve which occurs at the point where the ureter passes over the iliac artery in its transition from its pelvic to its abdominal portion. Such obstruction would occur about five inches from the vesical orifice of the ureter. Thereafter unless there be a true obstruction the catheter should pass readily into the renal pelvis.

It should be remembered that a stone lodged in the pelvic outlet or at one of the narrowings of the ureter does not always afford operative indications. In a majority of cases these stones, particularly if aided by free diuresis, prolonged hot baths and morphine pass into the bladder and thence through the urethra. This passage is accomplished usually in the course of hours, sometimes not for one or two days, and the probability of accomplishment is incident to the size of the stone, which may be determined by the X-ray and at times, to previous experience of the individual with attacks of renal colic. A calculus no greater in diameter than a No. 16 catheter may be expected thus to pass. A larger one, unless there have been repeated preceding colics causing ureteral dilatation, should be removed promptly.

The safety of the conservative policy in cases of calculus obstruction is dependent upon the presence or absence of infection. In the latter case it is allowable to wait for one or two days. When the renal pelvis is infected the delay should be no greater than that needful for operative preparations.

On general principles since stones located in the abdominal portion of the ureter are more readily accessible and removable than those in its pelvic portion it is desirable to reach them before they have descended to this portion of the canal. It is also true that in the absence of infection the stone operation is a safe one; in its presence one in which both the immediate and remote dangers are greatly increased.

When it is desired to reach the renal pelvis the incision varies somewhat in accordance with the patient. In relaxed, long-waisted, feeble muscled individuals with presumably freely movable kidney, the almost vertical cut passing parallel to the outer border of the quadratus lumborum muscle and dividing only skin, superficial fascia, often some fibres of the latissimus dorsi, and the lumbar aponeurosis is adequate. The renal fascia is divided and the kidney easily delivered upon the loin. This incision is open to the objection that the lumbar aponeurosis is cut at right angle to the pull of its attached muscle. Since no nerves are divided, the aponeurosis is sufficiently thick and interlaced to hold a suture and the line of union is not subject to severe strain, the resultant scar is firm and weakness of the abdominal wall not greatly to be feared.

For the thick, muscular, short-waisted and often fat individual, this incision is entirely inadequate. While more room may be obtained by carrying the incision obliquely downward from the costo-vertebral angle to a point an inch within the iliac anterior superior spinous process, this gives room where it is not particularly desired. It also involves cross cutting important muscles and aponeuroses with resultant weakness of the abdominal wall; weakness which usually results in hernia if from the nature of the case the abdominal wall becomes infected, or if the patient is subject, as not infrequently happens, to marked and prolonged tympany or to cough.

For the exposure of the renal pelvis of the short-waisted

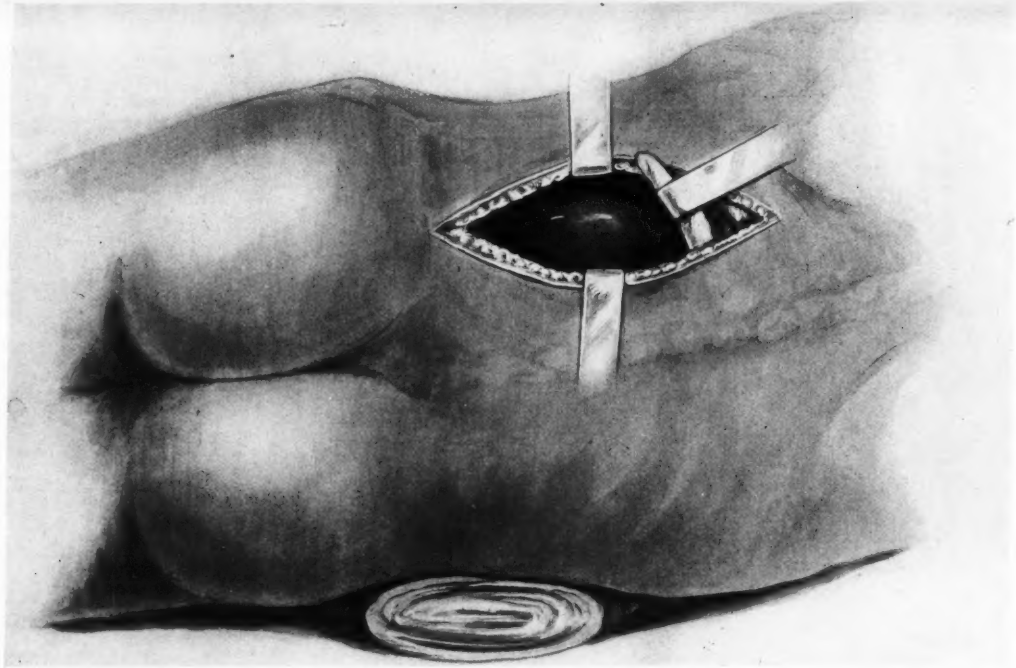


PLATE XIV.—Presented by Dr. Edward Martin

Patient in the right lateral position with pad under the loin. The muscle and fascial attachments have been freed from the tip and lower border of the 12th rib. This rib is retracted upward and outward allowing free access to the superior renal pole. The attachments to the 12th rib are the muscle fibres of the external oblique below and the latissimus dorsi and serratus posticus inferior above. The muscles of the costo-vertebro-pelvic triangle are retracted without section of the anterior muscle fibres. Before delivery the full extent of the kidney is easily exposed by this incision.

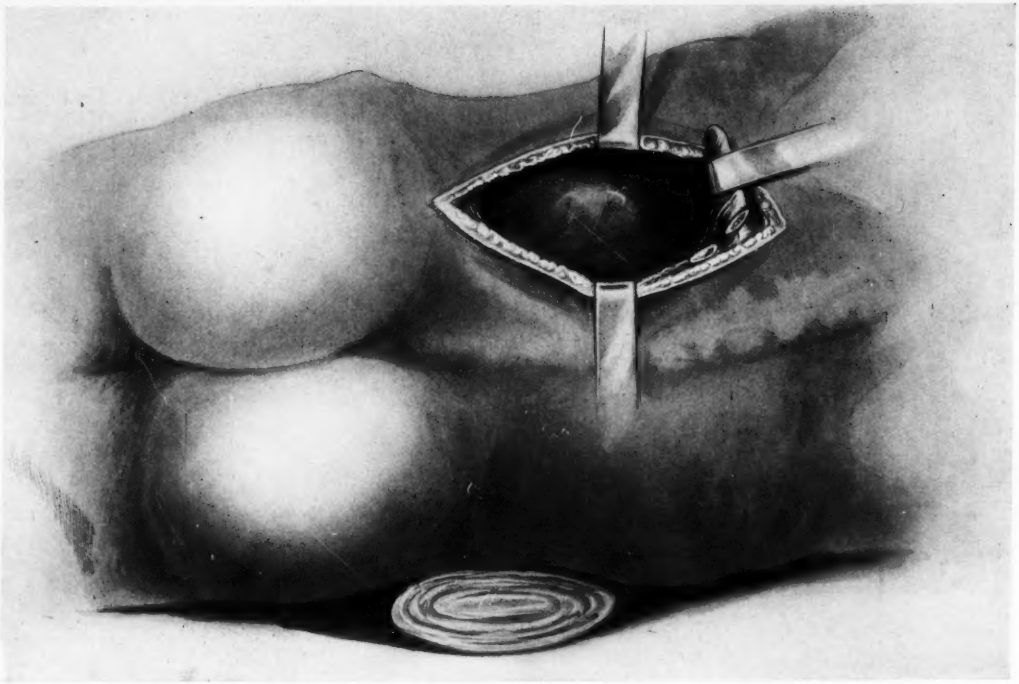


PLATE XV.—Presented by Dr. Edward Martin

Patient in the right lateral position with pad under the loin. The anatomical details of the previous illustration are applied in this exposure with a still better approach to the upper renal pole by section of the 12th rib close to the costo-vertebral articulation. Complete illustration of the rib from its muscle and fascial attachments except the intercostal muscle above is necessary before section and retraction. Reposition of the rib is easy after section. The diaphragmatic relations on both sides must be borne in mind to obviate opening the pleural cavity when rib section is performed.

muscular patient room is required high up. This added room is secured either by freeing and retracting, breaking back, or by section and removal of the twelfth rib, a procedure definitely formulated and described by William Mayo, and many lines practiced of necessity after fruitless and time-consuming efforts at exposure by the incision prolonged downward, by nearly all surgeons.

The cut starts over the bulge of the erector spinæ muscle at the level of the eleventh rib and with a pronounced downward convexity sweeps towards the umbilicus, stopping at about the outer border of the rectus muscle. The fibres of the latissimus dorsi muscle are cut through. The twelfth rib is exposed at once, the attachments of the serratus posticus inferior, quadratus lumborum and ilio-costales are rapidly freed by a subperitoneal stripping, easily accomplished by a curved aneurism passed subperiosteally around the ribs near its vertebral attachment and swept forward keeping close to the bone, the rib is broken back, or removed close to its vertebral articulation, or, as Mayo has shown, can now be so easily and efficiently retracted that it no longer serves as a factor in limiting the freedom of approach. The external and internal oblique require section of their fibres, the transversalis is split.

This gives adequate room for the recognition and control of aberrant vessels and provides the most direct route for the delivery of the kidney, hence facilitating pelvic intervention whatever form it may take. Moreover when the kidney cannot be delivered out of the wound there is an access so direct and free that the renal pelvis may be satisfactorily opened and sutured with the kidney still near its normal position. If the ilio-inguinal or ilio-hypogastric nerves be cut or clamped Judd's practice of a neat suture should be followed, preceded by resection of a crushed segment. The opening of the pleura usually avoided in this definitely formulated operation should it occur in the early part of the procedure before potential wound infection of renal origin has taken place is of minor

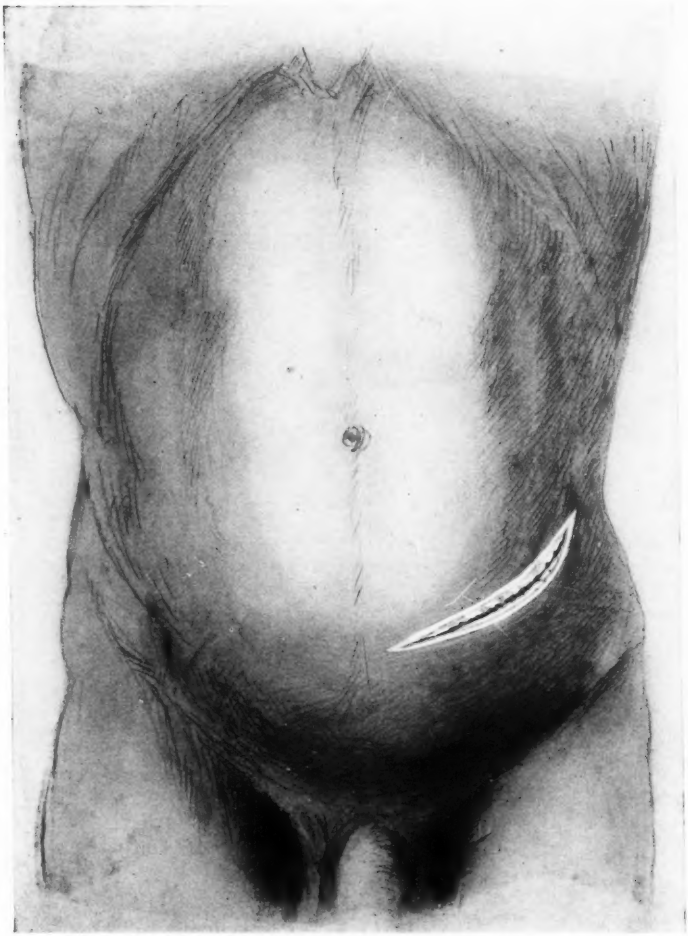
is performed.

moment since the pleural opening can be immediately closed by suturing; and even a slight pneumothorax is an exceptional complication.

This deliberately planned retraction or resection of the rib in a case recognized beforehand as difficult of approach, expedites the operation and makes it safer, avoids the traumatism of violent retraction always objectionable both from the standpoint of immediate shock and ultimate healing and is followed by as complete convalescence from the parietal wound as is any other form of approach. Where still more room is needful the eleventh rib also may be freed of its muscular attachments and retracted or broken back, and the incision may be carried forward to the midline, the rectus being freed by blunt dissection from its sheath, the two layers of the latter being cut transversely in the direction of the major fibres.

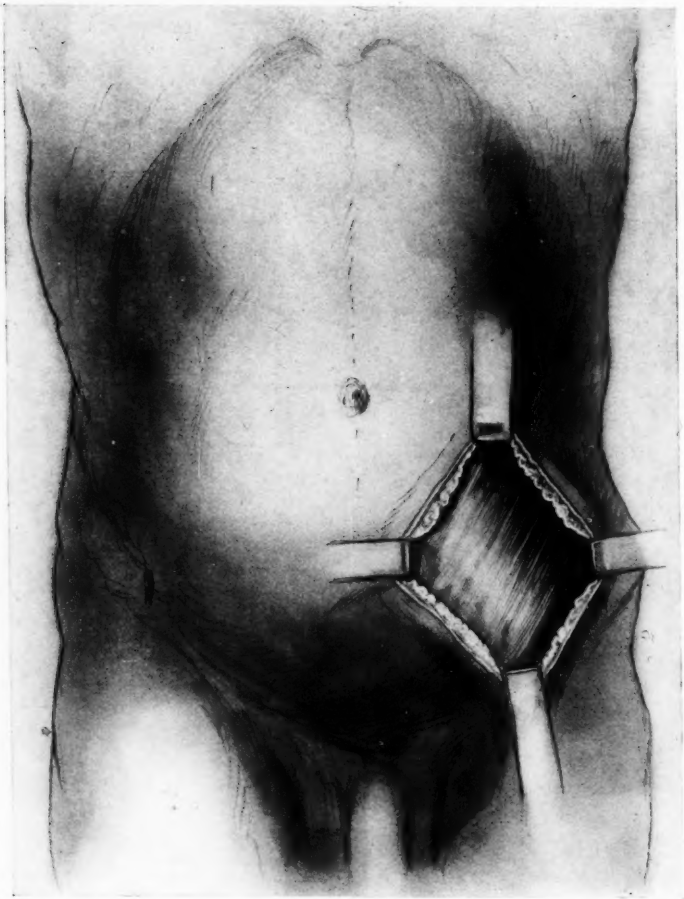
For the approach to the ureter at the first point of narrowing about on a level with the lower renal pole, a pure muscle splitting operation is usually adequate. The skin cut is a transverse one placed an inch below the last rib, and beginning at about the middle of the bulge of the erector spinæ muscle and passing towards the umbilicus as far as the outer border of the rectus. The latissimus dorsi, first encountered is cut or retracted. The fibres of the external oblique pass vertically through the posterior portion of this cut; these are split in the direction of their course and widely split since the free skin wound allows this. The fibres of the internal oblique pass upward and forward; a free splitting is practiced on this muscle. The transversalis, together with its fascia passes almost directly forward. It should be split well back upon the outer border of the quadratus lumborum. Thereafter the examining finger stripping the subperitoneal fat forward is passed directly inward until the outer border of the psoas muscle is encountered. Passing still further inward, over the psoas bulge the body of the second lumbar vertebra is felt. The ureter lies directly in front of

PLATE XVI.—Presented by DR. EDWARD MARTIN



Incision for exposure of lower abdominal and upper pelvic portions of ureter. Patient in dorsal position with lumbar soft pillow in place. Semilunar incision following surface lines of skin cleavage. This incision is about five inches in length, extends from point two fingers breadth above anterior superior spine of ileum to within one inch of linea alba. The skin and both layers of the superficial fascia are dissected back for some distance to facilitate retraction of deeper structures. All muscle and fascial splitting takes place with respect to direction of fibres of structures involved, whose integrity is thereby maintained.

PLATE XVII.—Presented by Dr. Edward Martin



Exposure of muscle and aponeurotic fibres of external abdominal oblique. Incision converted into a quadrangle by properly placed retractors. Anterior rectus sheath also freely exposed for transverse incision of its fibres if indicated. (Dissection by N. Ginsburg. Drawn by E. Faber.)

this psoas bulge, at this point about one inch wide, surrounded by subperitoneal fat and further invested in a fatty capsule of its own. Unless there be a fixed stone in it, or periureteric inflammation it cannot be identified by the sense of feel. A headlight, adequate hæmostasis and moderate deep retraction supplemented by long scissor and forcep dissection of the loose fatty tissue immediately overlying the psoas brings it into view, at times, on the right side, in immediate contact with the vena cava. Thus may be exposed the ureter most quickly and with the least effort and trauma. This approach gives adequate room for the necessary manipulation of lightly clamping the ureter above the seat of impacted stone, and incising and removing the calculus. A failure to clamp above in one case resulted in the passage of the stone back into the pelvis, thence into the second division of one of the calyces, requiring for its location and removal the turning out of the kidney and the splitting of this organ through its avascular line, converting an extremely simple procedure into a somewhat formidable one.

In the pelvic part of its course the ureter is best reached by a nearly transverse skin incision passing from an inch below and within the anterior superior spinous process to a little short of the midline. The abdominal muscles are split in the direction of their fibres and this splitting is carried well over the rectus sheath to give added room. The peritonæum with its underlying fat is stripped up from the pelvis until the finger encounters the external iliac artery; a mistake in the line of cleavage will result in stripping this vessel forward. It should remain loosely fixed to the pelvis and behind the fatty tissue stripped forward. The external iliac is followed upward and backward to its origin, the iliopectineal line answering as a fixed and easily recognized landmark in this deep blunt dissection, conducted entirely by the sense of feel. Anterior to the point of bifurcation of the common iliac artery or within half an inch of it lies the ureter. It makes an abrupt downward and backward turn, forming

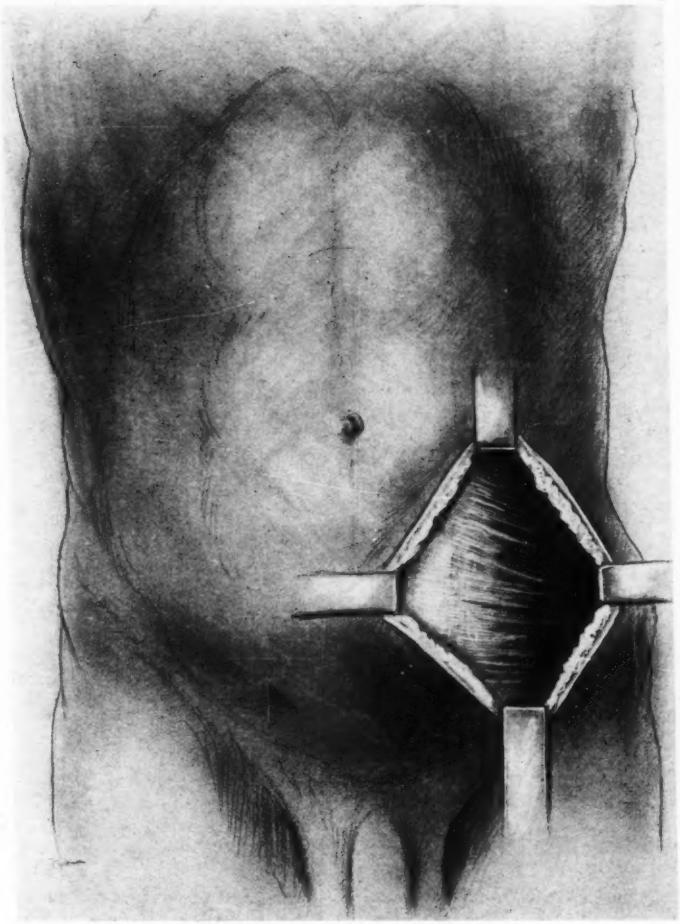
almost a right angle, in its further course corresponding closely to that of the internal iliac artery. It cannot be identified by the sense of touch unless it be chronically inflamed or contain a calculus, but a headlight and moderate retraction will show it as a fatty cylinder in thin people, scissors and forceps dissection in the region which it is known to occupy will make its identification easy in the fat. One or more large veins from the pampiniform, particularly when the operator has made his stripping high up and has first encountered the common iliac artery may lead to a doubt, settled by following downward the course of such a vessel which does not dip downward and backward with the internal iliac artery.

Although very definitely placed at the pelvic brim with abundant landmarks, the inner border of the psoas, the iliopectineal line and the promontory of the sacrum, and the bifurcation of the iliac artery, the recognition of the ureter may be time consuming and traumatizing, unless its capacity for dilatation in the presence of a low obstruction be remembered. It may readily reach the size of the small intestine and closely simulate gut in its appearance exhibiting a deceptive tortuosity and sacculation.

If the finger be placed on the inner border of the psoas muscle and carried up until its tip passes into a notch made by the body of the last lumbar vertebra and the inner border of this muscle, the ureter will be found from half to three-fourths of an inch below this point. If the finger be carried along the iliopectineal line from before backward it passes over the internal iliac artery as it dips backward. The ureter lies in close relation, almost contact anteriorly, with the artery at this point. Difficulty in finding it is usually due to a search too near the midline or to the fact that the transversalis or pelvic fascia is stripped up with the peritonæum.

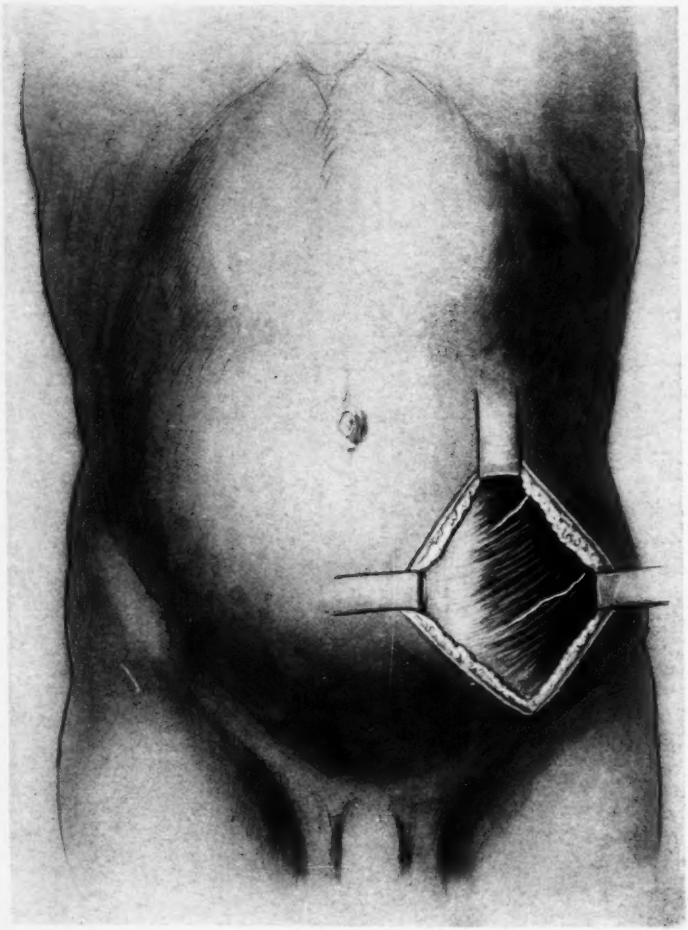
The isolation of the ureter, its gauze traction to the surface and the freeing of it downward from its loose pelvic attachment is readily accomplished. Through a longitudinal

PLATE XVIII.—Presented by DR. EDWARD MARTIN



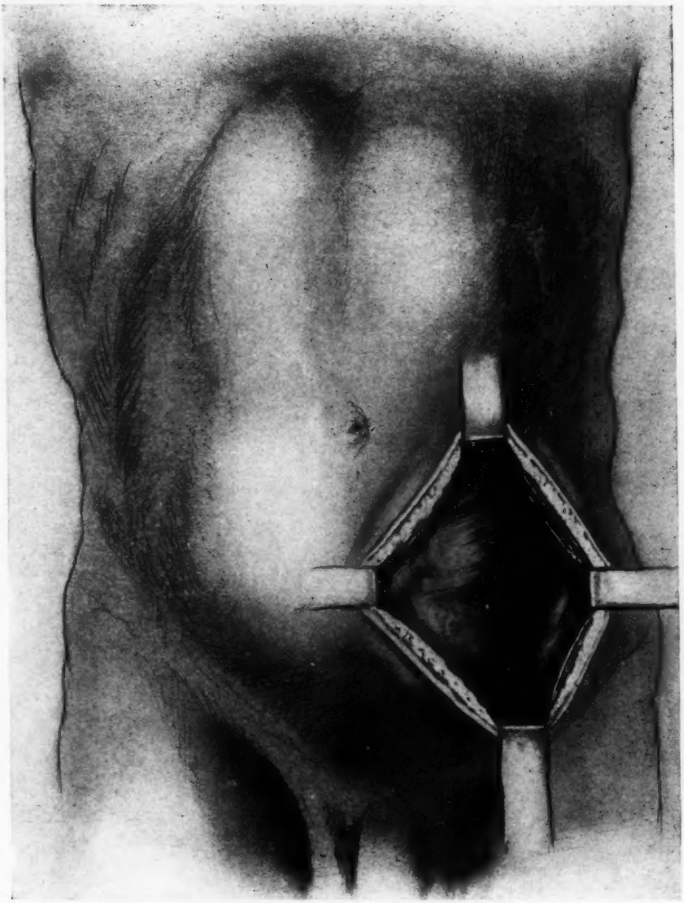
Exposure of the internal oblique muscle and rectus abdominis sheath. Note the ease with which transverse separation of the muscle and sheath fibres can be made. The division of the rectus abdominis sheath if necessary can be carried to the linea alba and the rectus muscle retracted medianward, thereby still further facilitating space for operative manipulation.

PLATE XIX.—Presented by Dr. Edward Martin



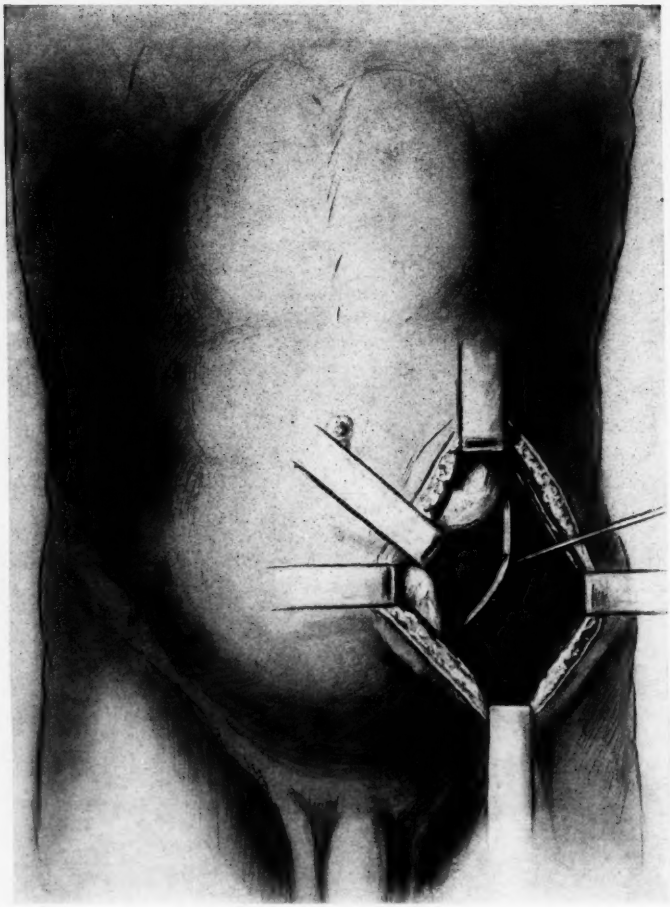
Exposure of the transversalis muscle by separation and retraction of the fibres of the internal oblique. Note the preservation of the lower intercostal nerves passing over the transversalis muscle to penetrate the rectus sheath, which is possible only by a separation of the muscle fibres with respect to their direction. Any incision through the muscle or fascial planes at right angles to the direction of their fibres must of necessity jeopardize the nerves, and predispose to subsequent relaxation of the area of distribution. The rectus abdominus sheath at this point consists only of an anterior lamellus formed by the triple aponeurosis of the three broad abdominal muscles. Complete transverse division of the sheath therefore anterior to the rectus abdominis muscle permits of retraction and allows of freedom of manipulation of the entire pelvic ureter.

PLATE XX.—Presented by DR. EDWARD MARTIN



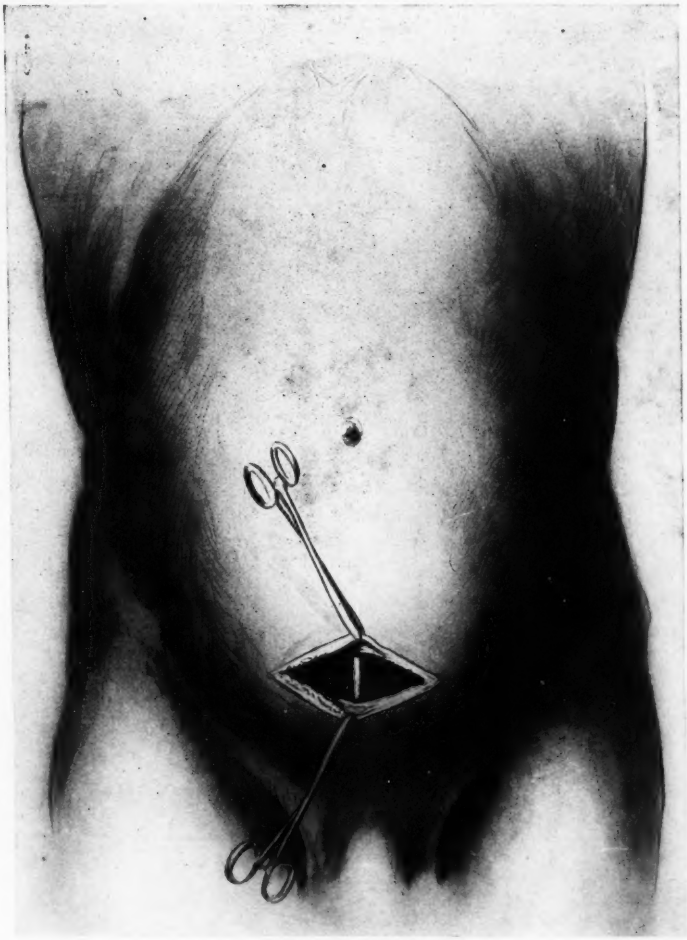
Division and retraction of all structures superficial to transversalis fascia, sub-peritoneal fat and peritoneum. Note the colic outline through the thin interposing structures. Insinuation of the hand between the outer wound margin and underlying viscus facilitates retro-peritoneal dissection as the next step toward exposure of the ureter. The peritoneum and tranversalis fascia are easily stripped from their parietal attachments as far as the promontory of the sacrum.

PLATE XXI.—Presented by DR. EDWARD MARTIN



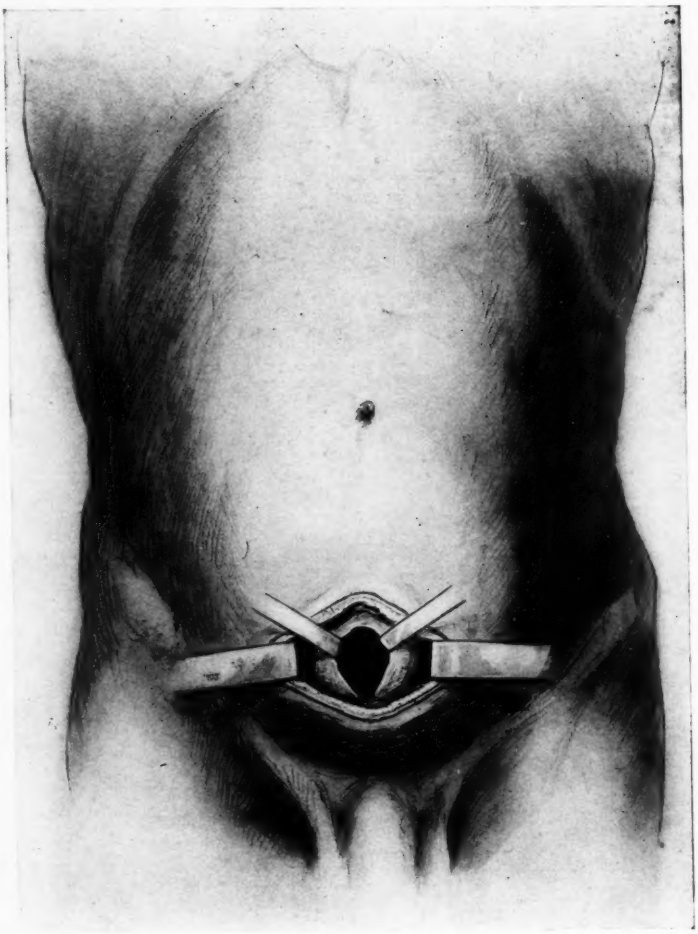
Ureter hooked up after gauze dissection and retraction of the descending and pelvic colon toward the median plane. The ureter crossing either the common iliac artery or the external iliac artery is found in the paravertebral fossa adjacent to the lower border of the body of the 5th lumbar vertebra. The inner border of the psoas muscle is a good guide directing the finger to the bed of the ureter. Inability to locate the ureter is usually due to search for it too far lateralward. The ureter as a rule comes up with the peritoneum, when this structure is stripped back, and has a vascular sheath of surrounding fat. By further separation of the peritoneum above and below almost the entire length of the renal duct can be exposed.

PLATE XXII.—Presented by Dr. Edward Martin



Patient in the dorsal position. Suprapubic extraperitoneal cystotomy for calculus in vesical portion of the ureter. Transverse incision through skin, subcutaneous structures and rectus abdominis sheath. The incision of the sheath extends across the recti muscles limited laterally by the lineae semilunares. Separation of the recti muscles is easy and sufficient retraction exposes the summit of the bladder; hence no structures are cut contrary to the directions of fascial or muscle fibres. Post operative hernia is unlikely.

PLATE XXIII.—Presented by DR. EDWARD MARTIN



Separation of recti muscles. Note the ease of extra-peritoneal incision into the bladder wall with exposure of its interior. The bladder incision should not be too far anterior and the prevesical and supra-vesical fat should be incised rather than separated by blunt dissection. Opening the bladder too far forward or too low down complicates drainage and greatly predisposes to suppuration of the space of Retzius.

opening in its wall a calculus lodged either at the pelvic crossing or low down in the post-vesical or even intra-vesical portion of the ureter may be removed by a proper instrument, providing a calculus of long standing has not formed for itself a pouch with a cicatricial narrowing above.

For low lying stones, post-vesical or intramural, a fine curved forceps with blades six inches long and rat toothed at the end, the teeth being inconspicuous and pointing slightly backward, usually suffices. Where there is no definite imprisonment of the stone by stricture above it, removal may be greatly expedited by a peritoneal opening, the fingers introduced through this either fixing the stone so that it may be seized by forceps or pressing it upward to the point of incision. This procedure, best formulated and popularized by Gibbon, is one to be adopted not only in these low lying calculi, but in all ureteral and renal operations where it is obvious that intraperitoneal manipulation makes the seat of intervention more approachable.

When the stone is placed in a post-vesical pouch of its own making and its removal through the ureteral incision at the pelvic brim is impossible, the transvesical approach is indicated. This is accomplished by a transverse incision a finger's breadth above the pubis, cutting of the rectus sheath in the line of the skin incision, the freeing of the rectus from its sheath by blunt dissection, the splitting of the transversalis fascia which is sometimes so marked as to constitute a posterior sheath of the rectus muscle, the traction of the bladder into the wound, the opening by a transverse or vertical cut and the passage of a fine grooved director into the ureter and splitting up of this tube until the stone can be reached and extracted. Such an operation obviously being indicated only when the stone cannot be reached and developed by instruments passed through the urethra.

DISCUSSION

Dr. Hugh Cabot, of Boston: I desire particularly to discuss the paper of Dr. Martin. This is a part of genito-urinary surgery in which I have fortunately had a good deal of experience, and I confess that I do not now use any of the incisions described by Dr. Martin, having used all of them and abandoned them.

In the first place, as to the upper portion of the ureter, it seems to me that in the cases to which a muscle splitting operation is applicable the more anterior incision, which I think is frequently referred to as Mr. Mayo Robson's incision, is preferable. It is distinctly an abdominal incision and is done with the patient in the dorsal position—it follows the direction of the external oblique at that point, and then meets that with a cross incision in between the fibers of the transversalis. That brings one down not upon the posterior but the anterior aspect of the renal pelvis, and in my experience stones lodge at the upper narrowing, lodge in a position to be accessible from in front quite as readily as from behind, if the point made by Dr. Martin of anchoring the stone is observed. This I think gives an adequate approach to the stone in any case in which a muscle splitting operation can be utilized.

In regard to resection of the rib, I do not take at all the view of Dr. Martin. I do not believe it to be a wholly harmless procedure. Pneumothorax I think not infrequently results. We had two cases coming one directly on top of the other within a week in which we got pneumothorax. In both of these cases the pneumothorax was overlooked until the patient was ready to go home, at which time a rather troublesome dyspnœa developed. Our medical associates were unable to detect this pneumothorax, and it was shown only by X-ray, almost a complete pneumothorax in one case, and the upper half in the other case. Both of these patients had troublesome dyspnœa, one for two and one for one month. It has been the experience of others I believe, that pneumothorax is not a wholly negligible thing. The resection of the ribs has not seemed necessary except in tumor of the kidney. I have yet to see a case of stone, whether in the kidney or ureter, in which a resection seemed necessary. However, I entirely agree with Dr. Martin's view that a great amount of handling of the wound is most objectionable.

In regard to the approach of the lower ureter I believe that the incision described before this Association by Dr. Gibson is superior to that just pointed out by Dr. Martin. It gives thoroughly good access to the lower two inches of the ureter, including the intra-vesical portion. I agree with Dr. Martin that a stone in the intra-vesical portion is best dealt with by the combined method, that is to say, by a finger in the bladder and a finger outside the bladder. I think a much lower incision, cross cutting the lower end of the rectus muscle, which I think was not

described by Dr. Gibson, gives a perfectly satisfactory exposure and the lower end of the ureter can be dealt with under sight. I have seen a considerable number of cases—three cases within the last two months in which a small stone impacted in an ampulla-like sac just outside the bladder wall in a contracted ureter, could not be pushed backward by any method. These small stones drift down to the bladder wall and then drop into the pouch frequently formed there by the dilatation of the ureter, and then the ureter above them contracts—in those cases no attempt to push or pull them back by means of forceps or any instrument which I have ever seen is likely to avail. They must be approached directly, and I feel that they can be approached directly through the incision of Gibson.

Dr. Francis R. Hagner, of Washington: In these low stones in the ureter it has been a great help to me to make an incision in the ureter just about the pelvic brim, and then pass a guide down the ureter until it comes in contact with the stone, and then open on the guide. That has facilitated these cases with me very materially.

I have had some cases where there was an ampulla-like formation in which the stone could not be moved at all. One was an old lady seventy-eight years old, who had had symptoms for twenty-five years, and the stone was very small.

Israel says that the operation should never be done intravesically unless the stone is poking its nose out of the ureter. From my experience I think that is an excellent rule.

Dr. Martin: The persistence of pneumothorax in Dr. Cabot's case suggests a peculiarity in the Boston air. Even though the pleura be opened pneumothorax is an exceptional complication. Yet that this accident does occur shows that it must be guarded against. All ureteral exposures do not imply a resection of the rib, if however, the canal and the pelvic expansion can not be made accessible by the simple muscle splitting, resection should be performed without hesitation. In dealing with the renal pelvis, it is usually needful to expose the kidney and often to turn it out, and in turning it out it is often least traumatizing in short, thick, muscular people to make a rib resection.

In regard to the postrenal part of the ureter the removal of a stone therefrom may be easy or most difficult. Once in efforts at extraction I tore away an ulcerated ureter removing the stone thereafter without great trouble. The kidney subsequently proven tubercular was afterward removed.

The operation proposed by Gibson I have tried on the cadaver; if the stone be palpable it may be a desirable procedure, but in cadaveric procedure the ureter is exposed with difficulty and only after going through a plexus of large veins.

THE COLON BACILLUS IN GENITO-URINARY DISEASES

By James Pedersen, M. D., of New York City

THE frequency and importance of primary colon bacillus infection of the urinary tract are of comparatively recent acknowledgment. The pediatrist, Escherich, and others, it seems, were the first to recognize the clinical picture, and when, in 1891 Krogius and Renault identified the bacterium of Clado, of Albarran and of Halle as identical with Escherich's bacillus coli communis, it was disclosed and established as the principal cause of inflammation of the urinary tract. Among the surgeons, Küster notably called attention to the disease.

Apparently, it was not until seven years ago, however, that the peculiarities of primary colon bacillus infection (of the urinary tract) were widely discussed. Wassermann, as recently as 1911, calls the disease an enigma throughout, and says that "it is seldom recognized not only in adults, but also in children." This we believe to be true, especially in the case of children. Though very common in them, it is easily overlooked because the usually insignificant local symptoms are so completely masked by the pronounced general symptoms, which are those of any infectious disease. A knowledge of these facts, and an alertness in detecting the disease are important, because of the danger to life after the kidney has been invaded. The disease is easily diagnosticated once it is suspected.

Knowing that colon bacilluria, while not a normal condition, is not pathologic of itself, yet may become dangerously so, we have to enquire how the bacillus gains the urinary tract, and how so innocent a saprophyte attains the virulence of which it is capable.

From a critical review of the literature, lately grown pro-

lific, covering the clinical and experimental aspects, the following data would seem substantiated.

Though of great motility, the colon bacillus is supposed to be shortlived in the blood current, as proved by the extreme rarity of a coli-sepsis (colon bacillus septicæmia.) Nevertheless, that it can and does live actively outside of the intestinal canal, is certain.

An hæmatogenous infection of the kidney or kidney pelvis, is no longer debatable, and a very direct infection by way of lymph channels has been demonstrated, notably between the hepatic flexure of the colon and the right kidney. This seems to be an anatomical fact. It will explain why the right kidney is more frequently involved than the left; but ptosis may be a predisposing cause. Conradi maintains that the colon bacillus is taken up by the leucocytes during digestion, even in health (the more so if any intestinal lesion be present), thus opposing the teaching of the French school, that a lesion of the mucosa must exist before the bacillus can escape. Meyer-Betz speaks of the lymph route between intestines and kidneys as "practicable."

In support of a primary ascending infection, there is the teaching of Lenhartz and others, who uphold the probable existence of a direct recto-vesical lymph-route, while admitting that in the severest cases the bladder has escaped infection; Melchior's discovery of the colon bacillus around the male meatus in 50 per cent. of the cases examined (Query: were they deposited there by the urine?), Kemp's report that 44.5 per cent. of all gynecological patients have colon bacilluria without attributable symptoms; the presence of the quiescent bacillus in both the male and the female urethra; the proven fact that regurgitation from the bladder up the ureters takes place, and finally, the aid ascending bacteria get from the normal ureteral folds, especially if sufficient urinary stasis be present to give an unbroken column of urine. Bacteria can ascend against the urinary flow. Equally they travel via the lymphatics of the ureter. Instruments, however, can not be

regarded as frequent carriers of colon infection from without upward; the disease (primary colon bacillus infection) is too common in children in whom there has been no occasion for instrumentation, and is so liable to occur in them after severe gastro-intestinal disturbances. On the contrary, spontaneous infection *per urethram* (without mechanical or other existing cause) is advanced to explain why the disease is more common in the female than in the male, and why the incidence in boys compared with girls, is somewhat greater than that in men compared with women.

The conclusion must be drawn that the evidence favors an hæmatogenous, descending infection, while not excluding the probability of an infection by way of the urethra, thence ascending.

As to the acquired virulence of the "innocent saprophyte," it is probable that some gastro-intestinal disorder is always the exciting cause of both the virulence and migration. Out of 44 gastro-intestinal patients, 16 had colon bacilluria. Intestinal stasis on the one end and urinary stasis on the other, furnish cultural opportunities, and when certain determining factors are added, the circuit is complete. Surgical operations (not those limited to the urinary organs) seem potent factors. Out of Rawl's 18 cases, 2 occurred in apparent health, 2 were postpartum and 14 were postoperative. Of the 18, 14 were primary in the urinary tract. Infection by the gonococcus, streptococcus or staphylococcus, exposure to cold, trauma, calculus and nephroptosis are other factors. On the other hand, primary colon bacillus infection may attack the apparently healthy with great suddenness, as do other infectious diseases. It may complicate those diseases. At least two of the observers insist that there must be either a loss of immunity on the part of the kidney pelvis, or some more positive antecedent lesion of the kidney before a colon bacillus nephritis, or pyelonephritis, can result.

To conclude the data on which prophylaxis may be based, it should be noted that of the 13 varieties of colon bacillus

obtained from fæces or pathologic states, 7 have been found in water and that according to the reports of the Department of Agriculture, at Washington, the colon bacillus is found on growing vegetation.

The typical course is chronic, punctuated by exacerbations, with a febrile movement, said to be like that of pneumonia, but starting like that of intermittent fever. The general, may mask the local symptoms. Sometimes it is afebrile; the first symptoms may be vesical irritation, due either to local or reflex causes. This was present in 10 out of 17 cases. A chill, now, will mean invasion of kidney pelvis or kidney itself.

Cystoscopy may reveal a variety of conditions from normal up to an appearance of tuberculosis.

The urine is typical of pyelitis or pyelonephritis. Pus is present in every case, and is variable, owing probably to some temporary obstruction in the ureter or kidney pelvis. Using Cohn and Reiter's 17 cases again, in 13 of which the ureters had been catheterized, the presence of colon bacilli was as follows: Bilateral, 5; right kidney, 5; left kidney, 3.

The literature on vaccine therapy or serotherapy, may be introduced by quoting Cohn and Reiter, who say that the "unsatisfactory results of surgical measures have led to *attempts* at serotherapy."

To the inconclusive results obtained in Germany, Michaelis and Rovsing independently are the exceptions in reporting satisfactory results.

O'Neil, in 1910, concluded that the treatment was useless in all forms and stages of pyelitis and pyelonephritis.

The consensus of opinion, at that time, was that vaccine therapy was *a* method of treatment, but not *the* method.

Since that date, a paper by Mackey, has appeared (1912), calling attention to the fact that vaccine therapy will fail unless the causative bacterium in the given case has been isolated. He mentions that the colon bacillus can be confused with half a dozen others. He reports 53 cases, 39 of which received vaccine therapy, and concludes that the method is of

doubtful value—the improvement being due to protracted treatment. To make this graphic, he adds:

(1) Mild cases recovered of themselves.

(2) Middle grade cases improved or recovered by drainage.

(3) Severe cases required surgery.

From these three statements alone, the indications for treatment can be deduced.

But, Mackey's contention is borne out by Jackson who, writing nearly two years ago, warned us that 17 varieties of the colon bacillus had already been isolated, and that the variety causing infection in a given case, must first be determined, and the vaccine be made from it before results could be expected. Wulff supports this view.

Assuming for the moment some value in vaccinetherapy, the difficulty in applying it to primary colon bacillus infection would seem due to the difficulty of isolating organism from others of its own species, from still others it resembles, and from those it may happen to be associated with or to complicate in the given case.

The recorded suggestions given in the literature as to medical treatment add nothing new—the alkalies, urinary antiseptics, very careful attention to the dietary and to the intestinal functions, sum these up.

Of 16 cases taken at random from our office records of the past few years nearly all showed gastro-intestinal symptoms to a greater or less degree. Three presented foci of antecedent infection elsewhere, namely, one case each of prostatic abscess, otitis media and antrum disease. This last presents some points of especial interest. The antrum disease occurred two years before and was unusually severe; the patient was ill from sepsis for several months. Ever since then the urine has contained more or less pus. In the course of an exhaustive investigation as to the cause and origin of the pus, ureteral catheterization showed the pus and colon bacilli coming from the left kidney, and a radiograph of that kidney

showed the presence of multiple calculi. The patient will submit to their removal as soon as he can adjust his engagements. Four cases gave a history of traumatism: one following the introduction of a sound by himself, a second following a rough digital examination of the prostate, the third following an unskilful use of a metal catheter for the relief of acute prostatic obstruction, and the fourth following an obscure injury to the region of the left kidney in which the focus of infection was found. One case gave a long history of chronic enteritis followed some years later by typhoid fever, and one case each of uncomplicated typhoid fever and ptomaine poisoning. In four cases fatigue with more or less exposure to cold played a part. Eleven presented residual urine; fourteen had bladder symptoms; three urethral discomfort, and five some degree of pain referred to one or the other kidney. As a matter of course, not every patient in the series was cystoscoped. In the nine cases in which this was practised, the bladder showed a variety of conditions from ordinary chronic cystitis with prostatic enlargement to appearances closely simulating tuberculosis, and showed the right kidney affected in two cases, the left kidney in five, with the probability of being the focus of infection in still two others.

The usual general and medicinal measures were employed in all the cases; the autogenous bacterins were employed in two cases with negative results, and a stock bacterin in one case with equally negative result. Three patients were subjected to prostatectomy which resulted in greatly improved, if not normal bladder drainage, without, however, causing the disappearance of the colon bacilli. One patient required nephrotomy and drainage; this put an end to his general symptoms and he has had no return of them in nearly a year but the urine still shows colon bacilli. Two patients submitted to nephrectomy with complete recovery from all symptoms and pathologic conditions.

The question I would raise is: Has not the advancement of our knowledge of tuberculosis of the urinary tract developed

our observation and comprehension of primary colon bacillus infection of the same, and is it not probable that that infection will prove to be of a seriousness not yet fully recognized? When we consider the wide range of pathologic conditions chargeable to the colon bacillus, varying as they do from perigastric adhesions at the center of our anatomy to arteriosclerosis at the periphery, is there not more truth than poetry in Robert T. Morris' remark that the colon bacillus as a depopulator is something to be reckoned with?

REMARKS ON THE RATIONAL TREATMENT OF GENITO-URINARY TUBERCULOSIS

By Richard F. O'Neil, M. D., and John B. Hawes, 2nd, M. D., of Boston, Mass.

IN this brief paper the writers wish to lay emphasis upon the fact that the best results in genito-urinary tuberculosis can only be obtained by supplementing the indicated operative procedure by long continued observation and treatment. Also to describe the methods in use at the Massachusetts General Hospital at the present time, together with the results so far obtained and some suggestions as to operative technique.

In surgical non-pulmonary tuberculosis the operation is but an incident in a course of treatment, by far the most important of which, comes before and after the operation. That is to say, it is rarely possible for the surgeon to remove all of the disease in a given case, the aim being simply to render the condition of the local lesion as favorable as possible for cure, which cure can only be obtained after months of constant and careful supervision. The attitude of surgeons has changed considerably during the last few years in regard to the operative treatment of tuberculosis, as is well illustrated by the present conservative operation for cervical adenitis as compared with the extensive procedure of the past. While there are conditions, as renal tuberculosis, which require quite extensive operation, the surgeon must recognize that his obligation to the patient does not terminate with his discharge from the hospital and that some provision for careful and intelligent observation and after treatment must be made if good results are to be obtained.

We believe furthermore an equally careful and constant supervision prior to any surgical procedure will vastly increase the benefit of such procedure and that this is particularly true in urinary and genital tuberculosis.

The establishment of a department for the observation and treatment of non-pulmonary tuberculosis at the Massachusetts General Hospital has been the result of gradual evolution.

The State of Massachusetts at the present time is fairly well equipped with accommodations for cases of pulmonary tuberculosis. This is not the case, however, with surgical tuberculosis, there being practically no beds available for adults in sanatoria or hospitals where patients with non-pulmonary surgical tuberculosis can receive adequate hygienic treatment. The reasons for this are obvious, in that surgical tuberculosis is rarely a danger to the community which has its hands full in caring for its dangerous and infectious cases. These reasons, although adequate, do not help the sufferer from renal or other surgical tuberculosis. It became increasingly evident that as the usefulness of the home sanatorium movement for pulmonary tuberculosis was becoming less and less, that in surgical tuberculosis it is and will continue to be a potent agent for good.

The department for the treatment for surgical tuberculosis is known as the "Tuberculin Clinic." This is a misleading name. It is true that in a great majority of patients, tuberculin injections are used in conjunction with other measures, in few if any cases would we be willing to attribute to tuberculin all or nearly all of the improvement. In some of the genito-urinary cases it has seemed as if tuberculin was an important factor in the treatment, in the great majority of cases, however, while a factor it is by no means the most important one in producing results. The tuberculin used is a bouillon filtrate supplied by Dr. E. R. Baldwin of the Saranac Lake Laboratory. It is administered once a week according to the rules of Trudeau, the initial dose being from .0001 mg. to .0005 mg., rarely .001 mg. This is gradually increased to 50 or 100 mgs. The increase in dosage is gauged by careful observation of clinical signs of reaction, local, focal or constitutional. Constitutional reactions have been rare and no untoward results have followed such as have occurred. Occa-

sionally benefit has seemed to follow a mild constitutional disturbance. It is the aim, however, to avoid all such and as a rule it has been possible to carry patients up to large amounts without discomfort. There is one marked exception to this in the case of a girl of 26 who had a nephrectomy done for tuberculosis. She also had a tubercular knee of long standing. This patient was much improved by her nephrectomy as to bladder symptoms and general condition. All symptoms were aggravated by tuberculin, a moderate dose causing increase in frequency, a flare up of the knee and a reopening of the sinus. This happened on three occasions. This was probably due to the fact that there was a considerable interval between injections and the dose given though small was too great for this particular patient.

This clinic is held once a week at the hospital and is composed of patients referred from other departments, particularly the male and female surgical and genito-urinary departments. The routine is as follows: When a new patient arrives, a careful physical examination is made to rule out any pulmonary involvement and a record of the weight, pulse and temperature is made. The method of treatment and reasons for all procedures are explained in detail, the patient is then sent to the Social Service Department (without which, or its equivalent, no such clinic could exist) with the request, "Please examine home conditions and report." This is followed by a personal interview with the social worker taking up the case in which the exact needs of the individual patient are explained. Also frequent consultations are held with the member of the Department referring the case with regard to treatment of the local condition. From the very first, every effort is made to secure the patient's cooperation and to see that she or he understand the reason for everything done. Patients are urged to attend regularly once a week until the process is cured or arrested. In a number of cases this cannot be done and some compromise has to be made. As the local and general conditions improve the patients are allowed to

come once in two weeks and when the process is arrested, to report once a month or once in two months. A record of the weight, pulse and temperature is made at each visit and the events since the former visit are carefully gone into, particularly as regards reaction, local or general. If nothing of note has happened the interview is short, if on the other hand, there has been a loss of weight or the patient has not been following directions, it may take some time. The lungs are carefully watched and whenever there is any suspicion of pulmonary involvement, radical treatment, usually in a sanatorium, is instituted. It is advisable and generally necessary that the patients with renal tuberculosis give up work for the first two or three months of treatment. This, however, is not always possible. The same applies as a rule to the patients with genital lesions although many of these keep at their regular work during the entire course of treatment. In some of both types the general condition has been so good that enforced idleness seemed an unnecessary hardship.

If a patient is under weight one quart of milk a day is added to the usual three meals and occasionally olive oil after meals. Unless patients are distinctly in need of more nourishment, nothing more is given provided that it is definitely assured that the patient is getting three good meals. Drugs are rarely used, except when there is painful and burning micturition. Then capsules of ol. santali or of guiacol carb. are prescribed generally with marked relief, some patients preferring one and some the other. Some patients sleep out of doors all the year, some during the summer months only. All are advised to and the question of plenty of fresh air at night is gone into in every case. Such in brief is the regime. Now as to results accomplished.

There are at present, or have been until recently, 24 cases of renal tuberculosis under observation who have had nephrectomy performed. Eighteen of these were referred from the genito-urinary service and six from the general surgical service. In addition to the eighteen, there have been four other

nephrectomies performed on the genito-urinary service for tuberculosis, three of which have not returned for treatment and observation but all were improved when last seen. There was one death 38 days after operation from sepsis and probably general miliary infection. Of these 24 cases, one case, that of a young woman of 26, left for her home in Sweden in failing general condition five months after operation, she having developed a pulmonary process. Bladder symptoms were unimproved and she was unable to work.

Another case, a man of 39. Fifteen months after operation has a tubercular wound, genital tuberculosis and an old process in the lungs. He is unable to work. He shows slight gain in weight and slight improvement but has only been back to the Hospital for a short time.

Another case which was under observation for a time, but is not included in the list is of interest. At an exploratory operation a single kidney only was found. Cystoscopy was unsatisfactory and an accurate diagnosis could not be made without operation; the symptoms were more in favor of a genital process. He has since died from pulmonary tuberculosis. In all the other patients under observation the lungs have remained free with the exception of a boy of eighteen who had a slight lung involvement which yielded to treatment.

The other cases all show improvement since operation, some to a very marked extent. In this series one case had a previous operation for bilateral tuberculous epididymis two and a half years previous to his nephrectomy. Another patient has had that operation performed since his nephrectomy, one and a half years ago. Still another case has had resection of the knee for tuberculosis since the nephrectomy, the joint involvement being of long standing.

The longest period elapsed since operation that we have record of is that of a patient operated on June 14, 1907. On April 9, 1913, she is working hard. Some frequency, at times a little blood; her general condition is good and she has gained weight. Another case operated on in August, 1905, last note

June, 1911. Some cystitis, some frequency and tenderness over other kidney. Two other cases three years after operation are working hard, one as a blacksmith, the other as a machinist. With the exception of the patient whose knee was resected and two of the very latest cases, all the other patients are able to work.

While all patients have made some gain in weight, there are a number where this has been marked; one a gain of 15 pounds, two of 20 pounds, one of 25 pounds, and one of 30 pounds; most of these have been made in a few months. Parallel with the increase in weight has gone a marked improvement in color and general condition.

All of these patients have suffered for varying periods of time from several years to several months prior to operation from pyuria and painful and frequent micturition. The amount of pus in the urine has diminished in all cases since operation. In some few the urine has become perfectly clear, in others nearly so, in the majority of patients the urine is cloudy but the amount of pus is much less than before operation. In regard to frequent and painful micturition: In nearly every case the pain and burning have disappeared. The frequency of micturition varies between wide limits. In one case where frequency was marked before operation, one year ago, he now holds his urine, which is clear, for seven hours at night. In a number of cases which suffered from marked nocturia, micturition occurring from four to eight or more times, now are bothered from one to three times only. The day interval being likewise lengthened. One patient who was obliged to wear a urinal before operation, micturition occurring every fifteen minutes, now goes from two to four hours and works hard.

Frequency, although diminished may be expected to persist to a greater or less extent in some cases for several months, some of our patients showing little improvement in this respect for a least three months. As a rule we employ no local treatment for vesical lesions. In a few cases instilla-

tions of gomenol oil have been used but not with sufficient regularity to form an opinion as to its effect. We employ internally the oil of sandal wood which has seemed to us to have distinct value. Frequency is a stubborn symptom but as a rule tends to lessen as time goes on.

The majority of the sinuses closed within a few weeks or less. Some remained open for several months. At present one case has been discharging for five months; it is, however, closing slowly. Another has had a good sized sinus for fifteen months. This patient had a pneumonia following operation and tuberculous infection of the wound. He only returned for close observation and treatment a month ago, but is already showing signs of improvement. In another case where the entire wound broke down, although the surfaces presented bright red granulations, there was not the slightest tendency to heal even after months. A secondary suture was undertaken with great success, the wound being closed except for a sinus at its upper end which healed solidly later.

Of late we have adopted the suggestion of the Mayos and after the removal of the kidney have closed the wound without drainage. After making sure there is no rent in the peritonæum the muscles are sutured in the ordinary way, a rubber tube being left to the cavity, 10 or 12 ounces of salt solution are then injected, the tube withdrawn and the wound closed. Five patients in the above series were treated in this manner. In the first case a small subcutaneous hæmatoma broke down about the fifth day but healed without trouble. In the other four, primary union took place. We regard this procedure as one which saves the patient much time and discomfort and even if not always successful, primary union is surely most desirable in wounds that may become so troublesome as these.

Such in general are the results thus far achieved in renal tuberculosis at our hands. On the whole quite satisfactory, when we consider the lack of sanatorium facilities and that the financial condition of so many of these patients makes it

necessary for the adults to return to work much sooner than would be the case under ideal conditions.

There are also under observation in the "Tuberculin Department" a number of cases of genital tuberculosis. These include at the present time nine patients who have been operated upon for unilateral or bilateral tuberculous epididymitis as well as some cases of inoperable genital lesions and one or two bilateral renal cases. What has been said of the general management of renal cases at the beginning of this paper applies as well to these groups of patients. Naturally these patients do not exhibit the striking changes that are seen in the renal cases. Still improvement is noticeable in many of them.

In conclusion we would again state that we do not attribute to tuberculin alone the improvement that has been brought about in these patients. We do, however, think it helps. There can be no doubt of the value of the psychic effects of the treatment for which patients will return regularly thus enabling us to keep them under observation with greater regularity and for a much longer time than would otherwise be the case.

The improvement noted in these patients we consider to be due to the judicial combination of surgery, proper hygiene, tuberculin and the careful consideration of the individual needs of each patient.

THE CURE THROUGH GENITO-URINARY SURGERY OF ARTHRITIS DEFORMANS AND ALLIED VARIETIES OF CHRONIC RHEUMATISM

By Eugene Fuller, M. D., of New York City

THE solving of surgical problems through experimental or, perhaps better, pioneer work is the interesting or absorbing feature of one's professional life, while the work along beaten paths is the bread winning feature. Many confine themselves to the beaten track and never tread on a new path until it has been, as it were, asphalted. Such men are perhaps the more popular from being the least criticized. Still, if a surgeon does not interest himself in new problems, he rarely preserves his alertness but tends to become stale and lacking in resourcefulness.

As many of the profession know, I have for a considerable period, devoted much of my time allotted to research, to surgery in connection with the seminal vesicles, important organs which hitherto had received almost no such attention. As the result, at the present time, of an operative experience in connection with 346 cases, much of the work which originally was experimental and research is no longer so but has been relegated to the beaten path of surgical routine. In numerous articles, I have, from time to time, acquainted the profession with the various groups of subjective symptoms which have been found to be curable as a result of the removal of lesions connected with the seminal vesicles through a resort to seminal vesiculotomy. The present paper is to deal with one group only of cases representative of a very chronic and advanced form of rheumatism which I have found to be likewise curable. My experience with and knowledge of these cases came as a sequel to preceding work in connection with typical gonorrhœal rheumatism, so-called, in its acute forms (Annals of Surgery, June, 1905; Medical Record, October 30, 1909, and June 15, 1912). In the last paper referred to, entitled "The

Management of Gonorrhœal Rheumatism," read at the 1912 meeting of the American Urological Association, much of this subject was considered, and, should one be interested, I would recommend a reading of that article, since the attempt will here be made to supplement rather than to reiterate the preceding communications. In that article, much fault was found with the term gonorrhœal rheumatism, especially as applied to the more chronic forms of the affection, and the opinion was positively expressed that a toxæmia independent of the gonococcus systematically absorbed from infected seminal vesicles was the cause for such forms of rheumatism.

Up to that time, owing to the depth of the wound leading to the opened seminal vesicles, and to its narrow path, I had found it difficult to obtain accurate smears from the interior of the sacs. Since then, however, thanks to Dr. Bradbury, Assistant Medical Visiting at the City Hospital, I have employed a smear carrier enclosed in a glass tube, the further end of which, as the tube is introduced, is plugged. A thread attached to the plug is pulled as the end of the tube enters the open seminal vesicle, after which the smear carrier is quickly pushed down so are to wipe the interior of the sac cavity.

Dr. Larkin, Pathologist to the City Hospital, in making cultures from these smears, has not discovered the gonococcus in these chronic conditions, but uniformly the streptococcus, and on one occasion a streptococcus of a peculiar pink or reddish hue, from which he made many cultures, all the progeny being characterized by the same coloring. The gonorrhœal fixation test has also been tried on very many cases representative of acute, chronic, and intermediate grades of rheumatism associated with gonorrhœa, and subsequent to gonorrhœa. In the more acute forms of the affection, the test was usually positive, and oftentimes in cases showing a marked tendency to chronicity the test would be positive a year or two after the time, according to the clinical history, the gonorrhœal infection had occurred. In one case a weakly positive test was found somewhat over five years after the stated oc-

currence of the infection. In most chronic cases, however, where there is evidence that a recurrence of gonorrhœal infection has not occurred, seminal vesiculitis persisting as a resulting lesion, the fixation test was found to be negative. The streptococcus could always be counted upon as existing in such cases.

When one considers that this genital lesion lies next to the rectum, the natural habitat of the colon bacillus, it is plain that such infection must finally take place by direct transmission through the intervening tissues, even though it may not have apparently ascended by way of the ejaculatory duct. In certain old chronic cases, a marked seminal vesiculitis and characteristic rheumatism would be found, wherein all questions as to the previous existence of a gonorrhœa would receive negative answers. In such cases, it was observed that the rheumatism would disappear with the postoperative disappearance of the seminal vesiculitis, just as in the cases wherein there was a preceding history of gonorrhœa. It is, of course, probable that in some of these latter cases—and perhaps in most of them—gonorrhœa had previously existed, notwithstanding answers to the contrary; still, in some of them it seemed most likely that the clinical answers were correct, and in a few it was highly improbable that they were not so. In the diagnostication of rheumatic conditions, gonorrhœa as an ætiological factor is commonly dismissed from consideration if not then actually present, or if it had apparently not been present during the incipiency of the affection. In order to avoid error, it is advisable, especially while considering chronic cases, to determine the condition of the seminal vesicles as a matter of routine.

Prognosis as regards the cure of absorptive rheumatism through seminal vesiculotomy, is decidedly good. In the paper on "Management of Gonorrhœal Rheumatism,"—Medical Record, June 15, 1912—the following statements bearing on this point were made:

"In the article already referred to, which appeared in the

Medical Record, Oct. 30, 1909, I reported my first 126 cases of seminal vesiculotomy. Of these, 35 represented cases of rheumatism. Since then, I have performed seminal vesiculotomy 125 more times, so that at present my total operative cases number 251. Of these last 125 cases, 87 represented rheumatism. With most of these the rheumatism, acute or chronic, was of a very severe grade, and it was for the relief of the rheumatism only that seminal vesiculotomy was performed. A minority of the cases had other clinical symptoms due to seminal vesiculitis, co-existing with rheumatism, as a reason for operation. In this last series, a much larger proportion represented rheumatic conditions than pertained to the first series. This is largely because rheumatism is the clinical symptom of seminal vesiculitis which usually, by incapacitating an individual, brings him to the hospital, and in my experience at the City Hospital, when those suffering from rheumatism see the rapid cures resulting with little postoperative discomfort in those who have been subjected to seminal vesiculotomy, there is such a scramble for operation that no time has to be wasted in persuasion. Out of 251 cases there has been no mortality, so argument against the operation on that score cannot be very impressive. In my last series, the results with rheumatic cases have been uniformly good. I attribute the better results in the second series to a more thorough performance of the operation and to improved postoperative details."

Since the preceding report of last year, I have performed seminal vesiculotomy 95 times, making my present total of cases 346. In this last series, the operation was undertaken for the relief of rheumatism in 69 cases. In connection with these last cases, I had one death, my first fatality. In this instance, the subject was an alcoholic with granular kidneys. Death occurred two weeks after operation, due to renal disease. I was aware of the fact that this patient was a bad surgical risk, before operation was performed, and had I in mind only the avoidance of the risk of possible postoperative death,

such a case could well have been denied operative relief. Many of my successful cases, however, have apparently been much worse surgical risks than this one. In these bad surgical risks, it has been found that, as a rule, the cure of complicating rheumatism has been of such systemic benefit that a recovery to a marked degree from independent co-existing ailments has frequently followed.

In this last series of 69 cases, between 20 and 25 have represented extremely chronic or most advanced conditions of rheumatism. In a number of them sufficient time has not as yet elapsed since operation for the end result to be attained. The more acute cases, aside from the one who died—and that patient stated a week after his operation that all his rheumatic symptoms had disappeared—were all discharged from the hospital in a very satisfactory condition. All were told to report at the clinic after discharge in case any disturbing symptoms occurred. Very few were seen afterward in clinic.

Of the chronic cases of this last series, there is one wherein true bony anchylosis of both hip joints had occurred, in which I am doubtful if the operation of seminal vesiculotomy has done any good. This is the first instance in which I have found true bony anchylosis instead of firm fibrous adhesions. I have had many other cases, however, wherein bony anchylosis had supposedly existed. In all such instances, forcible manipulation previous to operation, while the patient was fully under the influence of an anæsthetic, had demonstrated that no true bony anchylosis did exist, tendenous adhesions alone accounting for the fixation. Whereas in acute cases a cure of rheumatic complications following operation is rapid, it is natural in connection with chronic ones that the end result should be slower. In both phases of the disease, the operation, by draining the septic focus, puts an end to systemic toxæmia. In the chronic cases, the toxæmia may produce certain secondary lesions or results, which remain after the sepsis has disappeared, and it is not until these secondary lesions have vanished that a cure is usually reckoned.

The secondary lesions which require the most time for postoperative resolution are firm fibrous adhesions of joints and tendon sheaths, exudations of hard plastic lymph, and marked muscular atrophies. In the chronic cases, where the feature of the lesions is fluid exudation into movable joints, complete cure following operation is rapid. In very chronic cases, wherein the lesions resulting from the systemic toxæmia are most marked, it usually requires six months, and it may require two years before the final benefit following operation is attained. Formerly, in connection with chronically fixed joints and atrophic muscles, I prescribed massage and joint manipulation at the end of a month or thereabouts after operation. Experience has shown, however, that it is not advisable to prescribe such after-treatment. Much better results are attained when the patient is left to himself, with directions to gradually exercise and move more and more the parts involved. Massage and movements, when not applied by the patient himself, are apparently apt to be overdone, and consequently productive of too much reaction.

As the operation of seminal vesiculotomy is productive of a cure, by reason of the fact that it frees the individual affected of the septic focus accounting for the rheumatism, it naturally follows that the operation, to be successful, must accomplish its purpose. In my first series of 35 cases, results were not as uniformly good as those attending later operations, for the reason that septic foci in these early cases were not treated surgically as radically as in the later operations. This was observed chiefly in connection with chronic cases which call especially for radical surgery.

As I have frequently remarked, a temporary and usually slight return of rheumatic symptoms may show themselves a month or six weeks after operation, in cases wherein all such symptoms had promptly disappeared, after operation. This simply means that the external tract of the wound has healed prematurely before the deep portions have been thoroughly drained, the toxins so pent up accounting for the rheumatic

recurrence. On this account, it is very important not to allow such premature external closure but to maintain drainage tubes in position until the deep portion of the wound has thoroughly granulated and healed. Another essential surgical point lies in a thorough and free opening throughout their entire length of the affected seminal vesicles. In very chronic conditions, the sac walls are lined with pyogenic granulation tissue. Such tissue should be removed. Then, again, in such conditions wherein there exists much peri-seminal vesicular sclerosis, it is necessary to free the organs from surrounding adhesions, and oftentimes to make a counter incision into the sac opposite the cut which first opened the cavity. This counter incision divides the sac wall lying next the floor of the bladder, and should it be made to include tissue beyond the sac cavity, it is probable the bladder cavity would be opened. Although care should be exercised not to cut beyond the sac cavity, thus opening the bladder, still it not infrequently happens that urine leakage to a greater or less degree will take place into this genital wound, even though the bladder floor has not been incised. Such an occurrence as this may be observed in cases where the bladder wall lying over the sac has become adherent, infiltrated, perhaps riddled with sinuses, or attenuated by chronic sclerosis, all such lesions having extended to the bladder wall from the primary focus in the seminal vesicle. Urine leakage of this character does not interfere with a final good result from the seminal vesiculotomy. Sometimes, in cases such as these, where the bladder wall in contact with the seminal vesicle is extensively involved, the necessary surgical manipulation of the part after the counter incision into the seminal vesicle has been made will result in a tear or perforation through the bladder floor sufficient to admit a catheter of 20 French calibre, or thereabouts. If a perforation of such size occurs, postoperative drainage of the bladder should be established by the passage through the opening of a catheter. The treatment in this manner of cases so complicated, led me on a number of occasions to drain the

bladder along this post-prostatic route, independently of conditions in the seminal vesicles. In such cases, the incision through the floor of the bladder was made in the middle line between the seminal vesicles. Consequently, in this procedure the genital organs are not disturbed. I have published an article entitled "Post-Prostatic Cystotomy," Medical Record, October 22nd, 1910, devoted especially to the subject.

Another important operative feature after the diseased area has been thoroughly exposed is the introduction of the packing. Each seminal vesicle should be treated with a separate long strip of gauze, which should be so crowded in as to firmly and completely fill the open cavities. It is over this packing and between it and the rectal wall that the drainage tubes are placed. (For a description of the operative technique, see Medical Record, October 30, 1909.) In the way of description a brief clinical record of a number of cases will be given, which illustrates different phases of chronic rheumatism.

Case I. Man, 42 years of age, came to me four years ago. His rheumatism commenced sixteen years previously and had been so progressive that for the last seven years he had most of the time been bedridden. He had largely lost the motion and use of his fingers, and both wrists were fixed by adhesions, as were also the elbows. Ankles and knees were likewise involved. There was partial movement only of the hips. The spinal vertebræ were stiff and immovable and the ribs so fixed that breathing was wholly diaphragmatic. The neck was fixed. There was a history of gonorrhœa twenty years ago. Urine contained some pus and bacteria, chiefly streptococci. For his bladder condition, there had been much treatment without beneficial results. There was a marked seminal vesiculitis, very sclerous in character, and besides this there was a deep false passage leading from a tear in the floor of the membranous urethra under the anterior margin of the prostate. Seminal vesiculotomy was first performed, and two months later, a perineal cystotomy for the cure of the false passage. Six

months after the seminal vesiculotomy the patient had gained thirty pounds, and had in a large degree recovered the mobility of his joints. One year after the operation he was actively at work, and has continued able-bodied ever since.

Case II. Man, 47 years of age, transferred to my wards at the City Hospital a year and a half ago from the medical side, where he had been for three years confined to bed or at most sitting in a chair beside his bed. Patient could not walk, owing to rheumatic involvement of both feet and knees. These joints were also greatly swollen, and there was much fluid in both knees. On first inspection one would be apt to think the case one of dropsy. He had been a sufferer from rheumatism in feet and knees for ten years. For the first seven years he had been able to work part of the time between exacerbations of his affection. There was an indefinite history of gonorrhœa fifteen years, or thereabouts, before. There were no genito-urinary symptoms complained of. Examination showed the existence of a marked seminal vesiculitis. Seminal vesiculotomy was performed, resulting in a quick cure of the existing rheumatic conditions, together with the accompanying swelling. In less than three months the patient left the hospital fully recovered. The rapidity of the cure in this case was due to the fact that there was no fixation of the joints and no resulting muscular atrophy.

Case III. A young man, 22 years of age. This and the following case are reported because of the severe and precocious type of the affection. In these cases, in a few months conditions were reached which in many—and in fact, in usual conditions—would only have been observed where the affliction had progressed for years. The patient was brought to the hospital in an ambulance. The left thigh was sharply flexed and immovable. The vertebræ were also fixed. The right knee and ankle were involved. The least movement affecting any of these parts caused so much suffering that none was attempted, the result being extensive bedsores. There was much emaciation. The rheumatism commenced four

months ago, having been preceded two months by gonorrhœa. There was a marked and active seminal vesiculitis. Rapid and radical relief as regards pain followed seminal vesiculotomy. The patient was up with fair motion a month after operation. In two months after operation he was discharged able-bodied and well, and has so since remained.

Case IV. Twenty-three years of age. Progressive and precocious rheumatism for three months. In this case, there was a general involvement of joints and tendons. On entering the hospital the patient could not move except slightly in any direction, nor could he feed himself. He could open his jaws but little, and so could not chew food. There was great emaciation, bad color, and a marked appearance of cachexia. There was a history of gonorrhœa between two and three months before the commencement of the rheumatism. The seminal vesicles were rigid, sclerous and bound down by outside adhesions, showing that the septic process had extended extensively into the surrounding fibrous tissues. The condition of this patient was so grave that no one thought he could live longer than two weeks with existing conditions remaining. Without loss of time, seminal vesiculotomy was performed, a quick cessation of symptoms resulting. A month after the operation, the patient had gained twenty pounds. In two and a half months after operation he left the hospital fully recovered and able to work. This patient could have been discharged much sooner, but was kept for observation.

Case V. Man, 46 years of age. There was marked swelling of the right knee with some flexion and immobility of the joint. There was no fluid in the joint but a hard boggy infiltration. There was much pain on manipulation. The appearance presented was that usually classed as "white swelling." The use of the right hand had been lost by a progressive rheumatic affection which had caused a fixation of the wrist and the digital joints. Tendonous adhesions had so drawn the fingers as to cause considerable deformity. There was no evidence of gonorrhœa in the clinical history or as the result of

PLATE XXIV.—Presented by DR. EUGENE FULLER

Case VI. Showing fixation and contraction of right hip.
(*From photograph by Dr. H. H. Janeway.*)

examination. There was, however, a marked sclerous seminal vesiculitis. Seminal vesiculotomy was performed. Gradual and progressive resolution quickly commenced in connection with the joint lesions. Six months after the operation, the patient had entirely recovered aside from the fact that the movements of the right fingers and wrist were slightly less free than those of the left.

Case VI. Man, 30 years of age. There was fixation of the right hip with much contraction and deformity, as seen in Plate XXIV. These conditions had existed for over a year. There was a history of gonorrhœa three or four years previously. In the patient's opinion, that affection had caused him little trouble, and had promptly gotten entirely well. There was considerable discussion as to the true diagnosis in this case. As a chronic sclerous seminal vesiculitis existed, these organs were subjected to surgical operation, followed by a progressive and gradual improvement in the condition of the hip. Four months after operation, patient could move hip joint freely, and stand straight. He then walked easily, with scarcely a difference between the movements in the affected and the corresponding joint.

Case VII. Man, 35 years old. Complete fixation of lumbar, dorsal, and cervical vertebræ. The ribs were also fixed and immovable. The back was not bent, but was perfectly straight and rigid. There was complete fixation of the head at a considerable lateral angle. Owing to the fixation of the ribs, the breathing was wholly diaphragmatic. There was complaint of great pain the length of the spine, together with headache. When first seen, the patient was wearing a steel frame jacket to guard him against jarring sensations. His rheumatic affection had begun four years previously and had been steadily progressive. There was a history of gonorrhœa seven years before the commencement of the rheumatism. It was supposed that the gonorrhœa had ended in resolution in two or three months. Marked sclerous seminal vesiculitis was found to exist. Seminal vesiculotomy was performed, fol-

lowed by gradual and progressive resolution of the rheumatism and the resulting joint fixations. When last seen, two months ago, one year after operation, the patient was regularly at work as a laborer. The ribs were movable, the head could be freely rotated. There was still some remaining fixation in connection with the lumbar and dorsal vertebræ. Headaches and pain had not been a feature since operation.

Case VIII. Man, 47 years of age; bedridden and unable to move or to feed himself. There was much stiffness or fixation of all joints. The only joints in the whole body which could be functionated were those of the jaws. There was considerable muscular atrophy. The head was fixed to one side and forward. Plate XXV, Fig. 1, shows general conditions. Pains in connection with the joints were paroxysmal and severe. The rheumatism began sixteen years before and had been constantly progressive. This patient, when first seen by me, five months ago, had been a patient on the medical side of the City Hospital for three years. There was a history of gonorrhœa when a young man, but of no subsequent trouble. In this case, there was a marked sclerous seminal vesiculitis. Seminal vesiculotomy was performed four months ago. Five days after that operation, a condition of strangulated hæmorrhoids developed, which required operation. This hæmorrhoidal operation unfortunately disturbed the drainage tubes in connection with the seminal vesiculotomy, so that they were prematurely forced out. I feared that the wound in connection with the seminal vesicles would consequently heal prematurely, before sufficient time for drainage had elapsed. There was a rapid improvement in rheumatic conditions. Six weeks after operation the patient could feed himself, and considerable movement had returned in his joints. Now, four months after operation, there is some return of the muscular pains and some restiffening of the joints, though he can still feed himself. The wound closed prematurely, as I had feared. If the present relapsing conditions are not temporary, I propose

PLATE XXV.—Presented by Dr. Eugene Fuller

Fig. 1. (Case VIII.) Showing general involvement and fixation of the joints. *(From photograph by Dr. H. H. Janeway.)*

Fig. 2. (Case IX.) Showing extensive involvement of both hands and forearms as well as both knees. *(From photograph by Dr. H. H. Janeway.)*

to open the track of the wound for more and sufficient drainage.

Case IX. Man, 36 years of age. This case was of especial interest. The man entered the hospital on a stretcher, running at the time a rather high fever. There was swelling of both hands and forearms, and both legs to well above the knees were swollen. These swollen areas, besides being œdematous, were red, infiltrated, and very tender to the touch. Any movement of the parts caused so much pain that none was attempted. The trunk was marked with a late secondary syphilitic eruption, many of the lesions being rupial in character, indicative of a severe form of infection. There was also an urethral discharge containing gonococci. The clinical history was that four months, or thereabouts, previously gonorrhœa and a chancre appeared at or about the same time. A month or so ago the systemic symptoms already described commenced, and quickly increased in severity. Two full intravenous injections of salvarsan were administered without apparently any special relief except as regards the eruption. Then, as the Wassermann reaction was still strongly positive, three more full injections of salvarsan were given at ten day intervals. The fever gradually disappeared. The blood count showed only a slight degree of leucocytosis. The Wassermann reaction was negative after the five salvarsan injections. The gonorrhœal fixation test, however, was very positive. For a time after the salvarsan there was some renal congestion and some puffiness of the face. After a few weeks the renal condition became normal. Although œdema had disappeared from the extremities, still the rheumatic condition of the hands, wrists, and knees remained very active, as seen in Plate XXV, Fig. 2, which was taken at this time. To account for the rheumatic condition a marked seminal vesiculitis existed. These organs were embedded in an inflammatory exudate, which was extensive enough to fill the post-prostatic cellular space. After the salvarsan treatment, the patient was observed for two months, during which time there was no improvement. His

heart action and general condition seemed too feeble to warrant a seminal vesiculotomy. Finally, however, at the urgent request of the patient the operation was performed. He withstood the procedure without any undue reaction. The improvement after the seminal vesicles were drained was very rapid. Patient left the hospital well and active six weeks after operation.

The above results, which are only a few of many, give an idea of the wide field of usefulness which seminal vesiculotomy opens in the relief of rheumatic complications; and when one considers that there are numerous other resulting groups of symptoms which the operation in like manner relieves, it is not difficult to estimate its great value.

DISCUSSION

Dr. J. Dellinger Barney, of Boston: I should like to ask Dr. Fuller a question in regard to the anatomy of the seminal vesicles. It will be remembered that the lower end of the ureter lies between the bladder wall and the superior end of the seminal vesicle, and in connection with those cases of urinary leakage of which he spoke, in how many of those, if any, has the ureter been injured, and might it not in that way, account for the leakage of urine which he speaks of?

Dr. Fuller: In reply to Dr. Barney's question, I am positive that I never damaged the ureter in any case. In all these cases where there has been urinary leakage by passing a soft catheter it always goes to the bladder. The ureter lies to one side. Of course, it could be incised, but I have never so far met with such an accident. In some of these cases the bladder becomes very much attached through inflammation to the vesicles, and in former operations I was so afraid of damaging the bladder in such conditions that I did not do as radical an operation as I do now. I have never had any complicating trouble from urine leakage. I have never had any lasting urine leakage. I operated on a young engineer a few years ago, a very bad case, and he did have a slight leakage for a year afterwards, but he has gotten perfectly well, and he sent me his wedding cards about eight months ago. As a rule the leakage stops very quickly and the case just mentioned is the only one I recall where there was an element of delay in its disappearance.

Second Day, May 7th, 1913

A LARGE VESICAL CALCULUS. REPORT OF A CASE

By Alfred T. Osgood, M. D., of New York City

THIS specimen is presented as a curiosity only, a calculus of unusual size.

Composition: Center chiefly urate salts and uric acid—Remainder triple phosphates and organic matter.

Size: 9.5 x 9 x 9 centimetres or 3¾ x 3½ x 3½ inches.

Weight: 525 grams or 16.88 ounces.

J. R., a man 66 years of age, single, was admitted to my service at Bellevue Hospital on February 22, 1913. Born in England, he had lived in New York for about 30 years, employed as a clerk.

His general health had been excellent until two years before admission. No history of syphilis. Urethritis at 36 years of age and a second attack at 38 years of age when epididymitis was a complication. Symptoms referable to the urinary tract began seven years ago with a burning sensation during micturition. The urine appeared clear and normal to his observation for five years and there was no marked frequency of urination by day or by night and no sense of obstruction to the passage of urine during these five years. Never hæmaturia to his knowledge.

Two years ago, however, urination became difficult, frequent and painful, the urine became cloudy and foul-smelling and defecation was also painful. He had lost weight gradually during these two years and had lost his customary appetite.

He was a poorly developed, ill-nourished, anæmic little man who appeared rather apathetic, slept a great part of the time in the ward for the twelve days before operation and presented some of the physical signs of myocarditis, chronic bronchitis and arteriosclerosis.

His appearance, his complaints and the mass palpable per rectum gave him admission under the diagnosis of "Cancer of the Prostate" from the admitting office. Each voiding was of surprisingly large quantities of urine, 5 to 7 ounces which urine was very foul, turbid and contained much amorphous and triple phosphate deposit. Quantity in twenty-four hours, 40 to 60 ounces. No urine could be withdrawn by catheters which apparently reached the bladder and irrigation of the bladder could not be accomplished. Cystoscopy was out of the question. The urethra was small and presented constrictions at 3½ inches from meatus and in the bulbous portion although a sound sized 22 Fr. passed these points, sounds apparently did not enter the bladder cavity and did not encounter calcareous matter.

By rectal examination a very hard mass immovably wedged in the lower part of the pelvis constricted the rectum and below this a small atrophic prostate could be readily made out. Without an anæsthetic the involuntary and voluntary contraction of the abdominal muscles prevented the palpation of the mass with the hand upon the anterior abdominal wall as well as by bimanual palpation.

Radiographic examination revealed a shadow occupying the entire cavity of the bony pelvis.

Operation under gas and ether anæsthesia. Suprapubic cystotomy. The incision of the bladder wall was greatly stretched but careful search for a rent into the peritonæum after delivering the stone failed to discover such injury as may have been produced, yet the autopsy revealed a suppurative peritonitis. On opening the bladder, the stench was that of putrid tissue and it was manifest that the mucous membrane had sloughed away. The stone, grasped by unusually

wide-gaping stone-forceps, was delivered with difficulty after separating the bladder wall from the stone so that air could enter beneath it. A partial, loose approximation of the bladder and abdominal walls and the insertion of a large rubber tube into the bladder gave free drainage.

He died on the fourth day after operation.

The autopsy revealed:

Gangrenous cystitis
General suppurative peritonitis
Interstitial nephritis and pyonephrosis with small cortical abscesses
Interstitial myocarditis
Fatty liver
Adhesive pleuritis
Chronic bronchitis

Such enormous stones in the bladder are rare. In a search of the literature which cannot claim to be exhaustive, there are found about fifty cases. Of these twenty refer to autopsy records and museum specimens. Of about thirty cases in which operation was performed, fifteen have recovered and fifteen have died soon after the operation. In many of these cases the condition of the patient, as a result of carrying this stone for years, has been precarious when operation was undertaken for relief, as in my case. The mechanical obstruction together with the traumatism and infection which are practically always present, often lead to pathologic changes from which recovery is impossible.

Recovery has occured after operation for the removal of calculus weighing as much as 34 ounces.

Operation was performed by Cline, as referred to in Watson and Cunningham's "Genito-Urinary Diseases," in a case presenting a calculus weighing 46 ounces without recovery. Autopsy records refer to several cases with calculi weighing as much as 51 ounces.

SARCOMA OF THE PROSTATE. REPORT OF A CASE

By Alfred T. Osgood, M. D., of New York City.

DR. CHARLES NORRIS, pathologist to Bellevue Hospital reported that the masses of tissue removed by me in this case from within the capsule of the prostate by operation on March 13th, 1913, showed it to be a spindle-celled sarcoma (small cells). Of this particular type of sarcoma of the prostate there are recorded very few cases in literature, perhaps ten in all. Large and small round celled sarcomata are somewhat more numerous and of all forms of sarcoma primary in the prostate verified by competent pathologic authority there are not over fifty on record at the present time.

A young man (L. F.) nineteen years of age, a law student, was admitted to my service at Bellevue Hospital on March 13th, 1913, under the diagnosis of retention of urine due to prostatic abscess.

Family history: Presents no evidence of malignant or chronic disease. His father, mother, three sisters and four brothers are in good health. He had never been ill previously. There was no history of urethral infection. He had never been exposed to venereal disease. He had not lost weight. Felt well except for urinary difficulty. Two months before coming to the hospital he had noted some scalding sensation during micturition and later on noted that evacuation of the bladder necessitated straining. These symptoms gradually increased so that one month before admission (February, 1913) he consulted a physician who after palpation per rectum told him that he had a much enlarged prostate. This physician gave prostatic massage daily and electric treatment by rectum and directed that hot rectal irrigations be taken four or five times a day. This treatment was carried on for two weeks when urination became so difficult that catheterization was employed at first once and later

twice in twenty-four hours. Passage of the catheter became increasingly difficult and painful. He had had no chills, fever or sweating. Appetite good; bowels regular.

After entering the hospital the house officers found great difficulty, but finally succeeded, in passing a silk catheter and withdrawing sixteen ounces of urine of normal appearance. This relieved his pain, all of which was apparently due to bladder contraction upon this quantity of urine. There was no pain referable to the prostate.

Physical examination: Revealed nothing abnormal except a distended bladder and an enlarged, soft prostate. There was no rise of temperature above normal and the pulse and respiration were normal.

To me the prostate felt about the size of a hen's egg, softer than normal, symmetrical in shape and even in consistency. By this examination it was not unlike diffuse suppurative process in the prostate but the history found no explanation of infection and the gradual progression toward obstruction without constitutional symptoms pointed strongly to a growth producing obstruction.

Operation: Immediate operation was necessary for bladder drainage, (March 13, 1913). Gas and ether were administered. A grooved sound was readily passed and the membranous urethra was opened upon it. The tissues of the perinæum and the membranous urethra were normal. Young's prostate tractor was used to draw the prostate down. Exposure of the prostate was then made as for prostatectomy, and the usual appearance of an enlarged prostate beneath the capsule was present. Lateral incision was made in the capsule of the prostate and with the finger, enucleation was attempted to obtain tissue for examination. Masses of tissue the size of walnuts were easily turned out when it was evident that a neoplasm within the confines of the prostate was being thus broken down and removed. The tissue was very soft, pale gray, glistening, with red areas scattered through.

In this way all of the tissue that could be felt was shelled out through two incisions in the capsule. There was surprisingly little bleeding. A drain was inserted into each opening through the capsule and a rubber tube in the bladder.

The proposal was made to the family and to the patient to attempt within the next day or two a radical removal of the growth by excising the bladder and making bilateral nephrostomy or bilateral ureterostomy. There was not ready consent to this energetic surgery, and ten days elapsed with the rapid, ominous appearance of a mass beneath the skin of the perinæum and a protrusion of fungoid growth through the perineal wound with a mass appreciable by palpation through the abdominal wall.

On March 24th, I opened the peritonæum in the median line above the symphysis revealing a mass the size of a grapefruit between the bladder and rectum and intimately connected with these viscera. Considering the very great malignancy of this growth and its extensive involvement of bladder, urethra, perineal tissues and rectum probably, it was deemed wise to suture the bladder below the peritoneal covering beneath an opening through the abdominal wall to provide for easy suprapubic drainage when that became necessary.

Since March 13th, the tumor has grown rapidly. A fungus mass the size of one's fist projects through the perinæum and a large mass fills the lower abdomen to the level of the umbilicus.

For a time he was up and about but the tumor mass in the perinæum bled so readily and profusely that he has been confined to bed, rapidly losing weight and strength.

The bladder has not yet been opened anteriorly. He voids urine freely through the perinæum. There is marked obstruction of the rectum necessitating the daily use of oil enemata for aiding evacuation.

He is receiving now daily doses of Dr. W. B. Coley's

fluid-mixed toxins of streptococcus erysipelatus and bacillus prodigiosus. A most unfavorable case for any form of treatment.

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ANASTOMOSIS OF VAS DEFERENS TO EPIDIDYMIS OF OPPOSITE SIDE FOR STERILITY

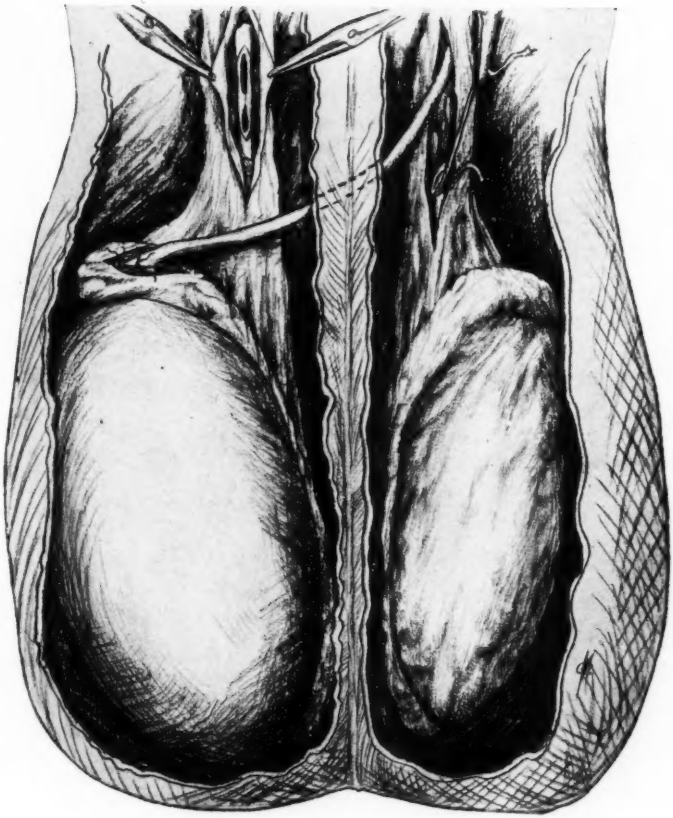
By Francis R. Hagner, M. D., of Washington, D. C.

THE following case of sterility following double epididymitis presented a phase that allowed us to do an operation that as far as I know has not been performed heretofore.

J. V., male, white, age 40, presented himself with a diagnosis of sterility following gonorrhœal epididymitis. Twenty years ago he contracted his gonorrhœa, which was complicated by double epididymitis. He has been married 15 years and his wife has never been pregnant. Repeated examinations have shown no spermatozoa. He was first operated on in the fall of 1910 and a bilateral anastomosis between the vas deferens and the globus major was done. At this time no spermatozoa could be obtained from the left globus major and even incision through the tunica alburginea showed no spermatozoa, this testicle being softened and atrophied. The vas deferens was patulous as indicated by a small probe. The right side was then operated on and a normal appearing testicle was found except for a thickening of the globus minor. When an incision was made into the globus major for anastomosis a few spermatozoa were obtained. These were non-motile and in this feature differed from those found in our successful cases. On examining the vas deferens on this side the finest tear duct probe could not be passed through its lumen although I went as high up as practical in the groin to get patulency.

The result of this operation was a failure and I suggested to the patient the possibility of bringing the good vas on the left side over to anastomose with the globus major on the opposite side, that is to say, the patulent vas of the left side to the better organ, that being the right testicle. At the operation the vas deferens of the left side was cut through and the

PLATE XXVI.—Presented by DR. F. R. HAGNER



distal end ligated; an opening was then made in the septum to allow the vas to pass through to the right side. Before the anastomosis was completed a small amount of argyrol was injected into the vas to be sure of its patulency. The appearance of the argyrol in the urine on the first urination following the operation proved its patulency. The anastomosis was then made although the condition present in the globus major of the right side at the first operation was present at the second operation, namely only a few non-motile spermatozoa. Patient made an uninterrupted recovery. (Plate XXVI.)

From our experience, this was certainly an unfavorable case because of the fewness of the spermatozoa and their non-motility. The operation as far as benefitting the patient was a failure, he being as sterile as ever; as proved by repeated examinations of the fluid collected in a condom.

Although this particular case was unsuccessful, there is no logical reason why other individuals presenting the same features except for the presence of motile spermatozoa should not be successful.

DISCUSSION

Dr. Edward Martin, of Philadelphia: The question of crossing the vas I have never put in practice. One man with a congenital absence of the vas was explored on the other side with this in view. His anomaly was bilateral.

In regard to the operation, under the most favorable circumstances it often fails, and under less favorable circumstances it may prove a success. Sometimes we have to make five or six different punctures before we get the spermatozoa. Sometimes in the vasa recta we get living spermatozoa before making an anastomosis and some of those cases have become fertile, and some have been the fathers of children. It is a gamble. I do not know why it should not be just as sure as any other anastomosis.

In regard to sounding the vas, we mostly use a fine strand of silkworm gut. Then we do not always have regular reports. Where they do not disappear they often come and give fictitious names. They go out of the hospital on the same or the next day and they vanish. So, many of them we never hear of again, though we always hear from the unsuccessful cases.

Dr. Osgood: I had a very interesting case of anastomosis between the vas and epididymis sometime ago. I have had a number of them, and some of them have only been successful after what was an apparent failure, i. e. successful after nine months, or a year even. During the interval no spermatozoa could be found at any time, but at the end of that time success was attained. I had a patient on whom I operated and investigated the vasa deferentia, and found both closed by stricture; they were sclerotic at different points for a distance of several inches. In this case nothing could be done apparently, and yet there were reasons in the family why a child should be produced if possible. I proposed the scheme which was carried out of incising the testis, where active spermatozoa were found, an emulsion was made of this material with salt solution, it was kept warm very carefully, and it was handed over to an eminent gynecologist who put it into a special syringe which I furnished and it was deposited in this man's wife's uterus. Impregnation did not follow.

With regard to prostatic fluid being necessary for the vitality of spermatozoa: These spermatozoa from the testis were very active, and spermatozoa are active in the testis without admixture of prostatic fluid. I could not use prostatic fluid in this case also as in Dr. Young's

case because the greater portion of it was pus. Spermatozoa are active in the testicle itself, and they were very active in this case. I mixed them with a little salt solution and used it in that way.

Dr. Edward L. Keyes, Jr., of New York: In reference to the interesting stone case of Dr. Osgood, I should like to call attention to the curious fact that a stone can get so large without troubling the patient. I operated upon and killed a patient, whose stone had been in his bladder for thirty-five years, with very mild symptoms.

Of perhaps greater interest are these rather amusing specimens, passed spontaneously by a patient of mine, the only instance I ever heard of spontaneous rupture of a number of calculi in a patient's bladder. He had been passing calculi for a number of years. He was alleged to have "Bright's" disease, when he was deprived for a time of all food except liquids and passed these fragments. I then had him X-rayed, with negative result, after which he began to get rid of these others. These subsequently passed ones are more rounded, showing they were probably all fractured at the same time.

Dr. Hugh H. Young, of Baltimore: In regard to large vesical calculi, I had an interesting case the other day, a boy who was brought in with evident symptoms of stone, and he gave an interesting history that five years before, feeling some peculiar desire he took a piece of paraffin and inserted it into his urethra and it disappeared and had never been seen since. At the operation I removed a stone almost four inches by two inches in diameter. I hastily cut it open, and there in the center of it was the piece of paraffin which he had inserted four years before. It was evidently inserted in the shape of a pencil, but it had become bent into the shape of the link of a chain and formed the nucleus of the calculus.

Dr. Osgood's report of a case of sarcoma has interested me very much. I operated on one case of that sort, and I think have seen at least three cases of sarcoma, but I am not sure of the other cases because I did not operate upon them nor get autopsies. I would like to ask him a question or two: What was the relation of the sarcoma to the prostate? In the case that I saw it seemed to me they were not really sarcomas of the prostate itself at all; and you would rather think from the glandular character of the prostate that you would not have a sarcoma of the prostate gland. In my case, although there was a mass almost as large as a cocoanut in the region of the prostate, when we got in perineally we found that the prostate was perfectly normal, sitting up on top of this

mass, which had evidently formed in the capsule of the prostate, having begun just about the juncture of the prostate and seminal vesicles. The prostate, which I got a piece of, was apparently normal and intact except where it was adjacent to the sarcoma at its upper end. In that case the whole bladder and urethra were pushed up, the urethra being greatly elongated, and the whole bladder being mashed flat by the mass. In my case I shelled out a mass of soft tissue with a spoon in large amounts, and much to my surprise the patient got a good result and did not have a return of obstruction until about a month or two before his death, which occurred a year afterwards.

Dr. Osgood's comments on the ingenious way in which he was going to try to impregnate the wife of his patient were interesting to me because I had a similar case and the same proposition, of getting some of the spermatozoa at operation and having an (equally eminent) gynecologist inject it into the uterus, occurred to me. I thought that it would be essential to mix the testicular fluid with the prostatic fluid, and I wonder whether the reason that he did not succeed in his case was that he injected immotile or non virile spermatozoa into the uterus and they ought to have been mixed with prostatic juice. Now in my case, unfortunately, the prostatic juice was almost entirely purulent, and the question arose as to whether we should mix the testicular fluid with his purulent prostatic fluid and inject it into his healthy wife. Of course, that we decided not to do. So the question arose as to whether it would not be possible to get some prostatic juice from a healthy individual. So I put that up to "the eminent gynecologist," who replied that if it were going to be necessary to go to all that trouble, he thought a simpler and more natural method could be found of using the prostatic secretion of the healthy individual!

Dr. Edward L. Keyes, Jr., of New York: I think Dr. Young's suggestion that sarcoma of the prostate is not sarcoma of the prostate is very striking, and leads me to report a case of lympho-sarcoma of the neck of the bladder (I am willing to say since I have heard Dr. Young's remarks) which I assisted Dr. Mackinzie to operate upon last winter. The case came in as a prostatic hypertrophy, a man in his sixties, with acute retention. It was a lumpy horse collar obstruction. The tissue at the bladder neck shelled out very nicely, and to our great astonishment we recognized the two normal lateral lobes of the prostate lying down below. Whether the growth was attached to the median lobe I am unable

to say. The pathological report was lympho-sarcoma. It grew very rapidly after operation.

Dr. A. C. Wood, of Philadelphia: I might refer to one case somewhat similar to those mentioned by Dr. Keyes and Dr. Young. A man was brought into the ward one evening with a huge hypogastric tumor, reaching as high as the umbilicus or higher. It was supposed he had retention of urine, but the resident physician could not get any urine by catheter. The patient died during the night. He was taken to the autopsy room and an autopsy done. They reported a huge retro-vesical sarcoma. Evidently it did not originate in the bladder; it did not seem to come from the prostate, but they could not determine where the original focus had been. The case seems to bear some relation to the two cases mentioned.

Dr. Osgood: Sarcoma of the prostate itself is a perfectly definite pathological entity. Many cases have been reported in which the prostate itself possessed a sarcoma within it at autopsy. In this case I feel very sure—in fact, I anticipated just this sort of difficulty of determining whether it was a sarcoma arising in the prostate or from outside tissues. I made a particularly wide exposure in order to demonstrate if possible, as far as one can by perinæum, that this mass was the prostate. The pathologist also reported that it seemed to be a growth arising from about the blood vessels.

Dr. Hagner: I would just like to speak of a case of sarcoma of the bladder that presents some interesting features. The interesting part of this case was it was operated on six years ago. I took out this growth and told the man's wife, who was a woman doctor, that he probably would not live six months. I simply left a drain in. The bladder was very badly contracted, and he was suffering very greatly before the bladder was opened. That man is living today. He is a good healthy looking man, and he still has a tube in his bladder, is still passing pieces of tumor from his bladder, and his wife won't let me or any other doctor see him. The pathologist's report showed a round celled sarcoma, but I have been very anxious to have a Wasserman done on him as I have thought that possibly it was a gumma of the bladder.

I can certainly bear out everything Dr. Martin says about the operation for sterility. I always tell these patients I won't make them any worse, but that I cannot promise anything further than that. We have had quite a number of successes now, and some of the cases we had not expected to be successful were successful, and some we did expect to be successful were not successful. But I do believe the motility

of the spermatozoa in the epididymis is an important thing. I think often you have to make two or three little incisions before you find the tubules that are not occluded. There is no question that the spermatozoa are motile, at least in the epididymis. I have done anastomosis in one or two cases directly in the testicle, but those were not successful. The only cases I have been successful with were where I used the finest silver wire for suturing, which may be a coincidence. I used fine silk in one case, which was unsuccessful, and fine catgut on two cases that were unsuccessful. I do not know whether that has any relation to it or not.

I tried exactly what Dr. Osgood did on a patient. This gentleman was a Rabbi. He had one atrophied testicle, and I never did find any spermatozoa in the other testicle. He insisted on artificial fecundation of his wife. I had a prominent gynecologist, and it was likewise a failure in that case.

A good many of these cases have chronic prostatitis, and yet I have had cases of sterility with chronic prostatitis and within a month or two after the anastomosis was made spermatozoa would be found in the fluid.

DRAINAGE OF THE BLADDER FOLLOWING SUPRAPUBIC OPERATIONS

By Charles H. Chetwood, M. D., of New York City

MOST of us will appreciate the great importance of efficient vesical drainage in connection with the high operation, on account of the faulty mechanical conditions that necessarily attend this procedure, which are more especially objectionable when the bladder is the site of an old chronic lesion, accompanied by decomposing urine and inflammatory products. The excellent opportunity of approaching the bladder afforded by this method, however, has given an impetus to the development of a proper means of drainage thereafter, which seems to have been productive of only a moderate success. Among different expedients tried have been the trap and syphon, used primarily by dentists, and a tip cup contrivance, that is regulated to overflow at required intervals and provide intermittent syphonage.

I especially recognized the value of the successful accomplishment of good bladder drainage attending a suprapubic operation this past winter for the removal of an enlarged prostate and vesical stones in a patient who weighed over 300 pounds, and whose abdominal wall was lined with a fatty layer of three or four inches in thickness. The result in this case was satisfactory beyond expectation. There was no fat necrosis, which so often occurs in such cases; there was no sloughing or purulent membrane during repair, and the bladder wound was practically healed three weeks after operation, the patient having been kept continuously dry for the entire period that is otherwise usually so uncomfortable. This was attained not by the ordinary method, but by the adaptation of the laboratory hydraulic pump, as has been utilized in operative procedures upon other parts of the body, and consists of a metallic hydraulic suction pump, attached to a convenient water tap, an aspirating bottle, and a fenestrated

tube, with a small interior canula, for introduction into the wound or cavity to be aspirated. For the bladder, a somewhat different arrangement is required at the wound. In the beginning, a large drainage tube is inserted in the bladder, in the interior of which is a smaller rectangular hardrubber or glass suction tube. The water is at first allowed to run continuously, so as to keep up the suction, and as the wound heals, and retention within the bladder commences, the nurse is instructed to start the suction apparatus at stated intervals, to be determined by the rapidity with which the accumulation of urine occurs.

When the patient is able to get up out of bed, he is still attached to his suction apparatus, and the smaller tube is inserted far enough into the suprapubic wound to reach the summit of the bladder, and the accumulation of fluid is thus immediately withdrawn by the action of the suction apparatus.

This method works better than any previous expedient employed, but it is not always possible to obtain a watertap for such purpose, especially in hospital wards and rooms that have no bathrooms attached; furthermore, it is not possible to obtain a constant and unvarying water pressure. Therefore, I have experimented with an electrically run aspirating pump, to be attached to any electrical outlet, and also have endeavored to substitute compressed air as a means of suction in place of the hydraulic system. The trouble is, however, in all instances, when the suction tube is obstructed by the accumulation of mucus or pus, the entire pressure of the vacuum in a tank or at a pump is exerted, which is likely to be excessive, and in some cases, to do harm. I have seen hæmorrhage started under such circumstances.

According to the principles of physics, if we have a vacuum of 25 inches in a tank, and an outlet valve which cuts it down to 3 to 5 inches, this is all right so long as no undue suction is exerted; but the minute unusual resistance occurs, the pressure to the total amount of the vacuum within the tank is exerted. On the other hand, most pumps which are so small

as to provide only a moderate suction for all the requirements, cannot do service for twenty-four hours in a day, and for consecutive days, without heating up.

After studying the situation out, we find the problem is to have a motor of low speed and a pump heavy in construction and also of low speed, so that both apparatus can be run continuously, day in and day out. Again, it is necessary, after setting the suction for the maximum requirements of the thicker substances that accumulate within the bladder, to provide a safety device that will blow out when the resistance exceeds a certain degree.

These requirements are all embraced in the apparatus which is here demonstrated, and which has proven its practical utility. The motor is 1/12th horse power, belted down to low speed; the pump is an inverted positive pressure blower used for air blast, of low speed, made very heavy, and heavily oiled. A small reducing needle valve is attached to the tube connecting with the drainage bottle, in which the amount of pressure is regulated, and after regulation the safety valve prevents any excess of suction. The amount of this pressure may be measured by means of a vacuum gauge. This apparatus, on account of its very heavy construction, can be run continuously without heating up. It is all included in a sound-proof box, so as to avoid the annoyance to the patient that might arise from the sound of the continuous action. This may be attached to any electrical outlet, and is constructed (by the Western Electric Company) for both alternating and direct current.

Another feature of such an apparatus is that in a ward where more than one patient requires its use, all can be attached to the same system by additional pipe connection.

The advantages of this effective means of drainage are:

First, the possibility of leaving a smaller suprapubic opening than is ordinarily required.

Second, the constant removal of fluid blood, thus avoiding clot formation and undue discomfort and strain.

Third, the surfaces of the abdominal cut are kept clean, instead of being bathed in fetid urine.

All of these advantages combine to insure a more rapid healing, with the patient out of bed in a minimum period, thus removing from the suprapubic operation, which all grant is a superior method of approach, that which, more than any other reason, has made it compare unfavorably with the perineal operation, namely, absence of adequate surgical drainage. I must acknowledge that in the large number of my cases I have found it entirely impracticable to eliminate the requirement of suprapubic drainage, notably in prostatectomy. There are some cases of stone in the bladder where the stone can be removed, and drainage obtained, by way of the urethra. Such cases are the exception, and not the rule. I therefore, in suggesting this method of obtaining bladder drainage, commend its adoption as a device that does not complicate the management of the after-treatment by adding to the difficulties, but is really a practical solution of the main disadvantages attending the suprapubic operation. It consequently possesses real merit in expediting recovery, and even in lessening some of the attendant dangers.

DISCUSSION

DR. BRANSFORD LEWIS, of St. Louis: I want to speak about the drainage arrangements of Dr. Chetwood. I think that that would certainly accomplish what he is after, but I have a little question in my mind as to the advantage of accomplishing what he is after. I believe that an intermittent suction of moderate strength is a little preferable to the continuous form of suction—the intermittent form by an apparatus such as that provided by Bremmerman, in which the degree and frequency of aspiration can be regulated perfectly. It is portable and can be moved around, or a half a dozen can be in use. I make use of this procedure a great deal following both the perineal and the suprapubic operations. I believe Dr. Chetwood accomplishes very nicely what he goes after, but I believe the interrupted suction, that is regulated by the cup, is preferable to the continuous, and also preferable to that method by which he directs the nurse to turn it on at regular intervals.

DR. CHETWOOD: In response to Dr. Lewis, I would like to say that I have used the Bremmerman apparatus, and have even been guilty of getting up a tip cup arrangement myself that did not work satisfactorily. This apparatus I have experimented with a good deal, and have proved it to be absolutely harmless. The suction arrangement can be reduced until there is no constant impact upon the bladder. There is a large tube introduced into the bladder and then in the center of that is a shorter tube, around which is a circulation of air, so that it really does not make any suction at all until the level of the urine reaches the inner tube, when, of course, suction should be exerted.

An additional arrangement has been added to this apparatus in the nature of a clock which can start the apparatus going at stated intervals, so that when you learn what the tide of urine is you can set your clock, or this can be accomplished by having the nurse push the button of the apparatus at stated intervals.

The trouble about the Bremmerman apparatus is that oftentimes the suction is not sufficient. An apparatus is required that will give the desired amount of suction, and will not do any harm. While I appreciate the objections raised to such an apparatus, I think they have been overcome by the refinements added to this one.

THE OPERATIVE TREATMENT OF ACUTE GONORRHŒAL EPIDIDYMITIS

By John H. Cunningham, Jr., M. D., of Boston, Mass.

SINCE Dr. F. R. Hagner first published (in 1906) the technique and results of his method of operation for acute gonorrhœal epididymitis his method has been employed by many surgeons. The experiences of others as well as that of Dr. Hagner have been published from time to time in medical literature. A study of these reports shows that there exists a uniform opinion in regard to certain features of this method of treatment, which are that this procedure when applied to cases of severe acute gonorrhœal epididymitis is followed by immediate relief of pain, a drop in temperature and of leucocytosis, and that the convalescence is materially shorter than it is by the expectant form of treatment. In no report is there mention of any recurrence of the disease in the organ operated upon. In a large proportion of the cases the absence of a recurring active urethral discharge after the operation has been significant and in some no recurrence of the urethral discharge has appeared. Whether or not this operative procedure lessens the percentage of sterility in the individuals who have the disease in bilateral form has not been determined.

It is with the desire to add my experience in support of this form of treatment and to speak of the pathology and of the subject of sterility following this method of treatment in bilateral cases, that this communication is presented.

Acute gonorrhœal epididymitis cannot be considered as being other than an acute inflammation of this appendage. The operative interference in this malady is the simple application of the principle of drainage to an acutely infected organ. It appears that Pirogoff recognized this fact and punctured an acutely inflamed epididymis as far back as 1852, and H. Smith in a publication in 1864 mentions a series of a

thousand cases in which he punctured the acutely inflamed epididymis with beneficial results. It appears that the value of drainage in this disease was lost sight of until Hagner published his technique in 1906.

As is well known, acute gonorrhœal epididymitis is very common. It is variously estimated to occur as a complication of gonorrhœa in twenty to thirty per cent. of the cases. Gonorrhœal epididymitis results from an extension of a posterior urethritis along the ejaculatory ducts and vasa deferentia. Infection of the prostatic glandular tissue (prostatitis) is usually present before this extension takes place. Occasionally the prostate may escape the infection, the inflammation extending almost immediately to the epididymis from the deep urethra. Inflammation of the ampulla of the vas and the seminal vesicle generally takes place also. The inflammatory process continues along the mucous membrane of the vas to the tail of the epididymis where the extension of the disease is usually arrested, probably because of the convoluted character and minuteness of the canal. In the severer forms of the malady, the body and head of the epididymis are also invaded. Epididymitis is usually unilateral. Double simultaneous epididymitis is extremely rare. Subsidence of the process within one organ and its subsequent appearance in the organ of the opposite side in the course of a few days is not unusual. Why the inflammation extends along one duct and not the other at the same time, when these two ducts open at a distance from each other of but a few millimeters is not clear. The extension on one side only may be due to the occlusion of one opening by swollen mucous membrane, while the other remaining patent allows the infectious product to gain entrance.

Since 1906 the writer has employed this method of treatment in most of the cases of acute gonorrhœal epididymitis that have been in his care and has not restricted the treatment to the very severe forms of infection as Dr. Hagner has done. In collecting the material for this paper, there are fifty seven cases from which reliable deductions may be drawn. Of

many other cases upon which the operation was done, so little is known that they are not mentioned except to say that the immediate relief of the symptoms is known to have taken place.

From some of the patients pieces of the epididymis were resected for the purpose of pathological study which is one part of this communication.

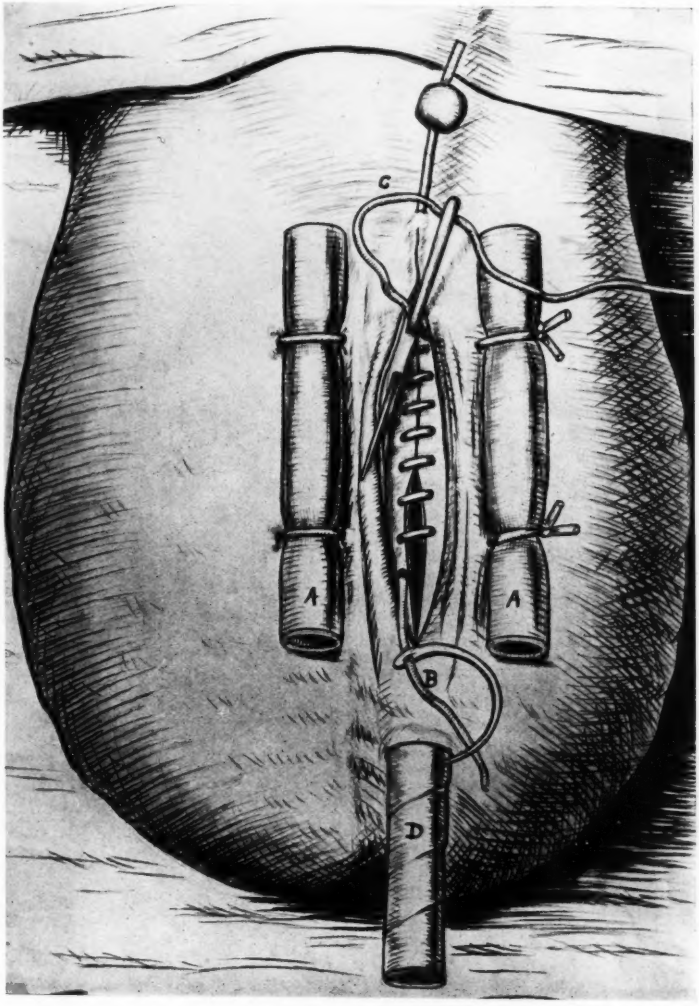
There were six patients upon whom a bilateral operation was done. From these observations have been made with regard to the occurrence or absence of sterility.

Hagner's technique, with the exception of closing the wound, has been followed in most of my cases.

Hagner's technique is as follows: The junction of the epididymis with the testicle is defined and an incision about two inches long is made through the scrotal skin along this line. The tunica vaginalis is opened and such fluid as may be present in its cavity escapes. The swollen epididymis with the testicle is delivered. The epididymis is now punctured in many places with a narrow bladed knife in the inflamed area. The punctures must penetrate the infiltrated fibrous covering and the body of the epididymis must be entered by the point of the knife. If pus escapes from the punctures the opening through which it makes its exit is to be enlarged and the cavity from which it comes washed out with a corrosive sublimate solution of 1-1000 strength by means of a syringe.

If the punctures do not yield pus after the punctures have been made through the fibrous covering, they should be probed with a small probe or director. In this way, foci can be opened, at times, that may have escaped puncture with the knife. The epididymis should be squeezed and its surface and that of the testicle and tunica vaginalis sponged with a corrosive sublimate solution of a strength of 1-1000, followed by a sterile saline solution. The testicle is then replaced; a puncture made at the bottom of the scrotum through which a rubber dam drain is placed in such a way that it lies along

PLATE XXVII.—Presented Dr. J. H. Cunningham, Jr.



Manner of closing the scrotal wound.

A–A. Two rubber tubes over which are tied the silk worm gut sutures passing through skin dartos and tunica vaginalis.

B. Catgut suture uniting the edges of the tunica vaginalis.

C. Subcutaneous silk worm gut suture closing the skin wound.

D. Drainage tube placed along the outer side of the punctured epididymis.

the outer side of the whole length of the epididymis. The skin wound is then closed by passing two silkworm gut stay sutures through the skin, dartos, and tunica vaginalis and tied over rubber tubes, one on either side of the wound. The tunica vaginalis incision is closed by continuous fine catgut suture and the skin incision by a subcutaneous silkworm gut suture. A sterile dressing and a supporter are applied. The stay sutures are to be removed at the end of the first twenty-four hours, their purpose having been to prevent the dartos from retracting and thus causing ecchymosis of the lax scrotal tissue (Plate XXVII.)

The drainage dam is removed on the second day. Most cases are up on the third or fourth day. The silkworm gut suture is usually removed on the eighth day. In many of the cases the catgut knot has worked out, which has delayed healing. If the two silkworm gut stay sutures prevent all bleeding from the dartos, as they usually do, the catgut suture of the tunica vaginalis may be omitted.

The writer's experience in the performance of this operation has shown that in all but five cases there was fluid in varying amounts in the tunica vaginalis. Of these in which this fluid was examined, no gonococci were found, nor were any other organisms present.

In the five cases in which there was no fluid there was an agglutination between the visceral and parietal layers of the tunica vaginalis brought about by an inflammatory exudate which bound the epididymis to the parietal layer.

In all of these cases the disease was over three days' duration and in all but one it was of five days or more.

In sixty-seven per cent. of the cases gross pus in varying amount was demonstrated, and in those instances where it was not present, the material obtained by the punctures was examined microscopically, and pus was found. The latter class included all the cases of short duration.

From this fact it is believed that if these cases were left

without operation they would have gone on to resolution or to the pathological condition seen in those of longer duration.

The organisms found in the pus from the punctures of the epididymis have always been gonococci. When the gross pus was examined this organism has usually been found. In the cases which were operated upon early, before gross pus was present, the gonococcus was often but less frequently found.

The testicle has never been observed to be involved except by the extension of the epididymal congestion over its surface.

In regard to the post-operative observations, the absence of pain on recovering from the anæsthetic has been the greatest recommendation for the operation; the fall of temperature and of the leucocytosis and the rapid disappearance of all evidence of toxæmia has been the same as in the cases reported by others. The convalescence has been materially shortened as compared with that seen in connection with the expectant form of treatment.

The urethral discharge has recurred in all but four of the cases, but it is a noteworthy fact that the recurrent discharge was seldom as severe as when the disease is treated by palliative measures. In the majority of the cases the subsequent treatment of the prostate and the seminal vesicles was not so prolonged as it is in the average case of the disease in these structures without the concomitant development of acute epididymitis. This feature is not easy to understand. It is, I believe, important to treat the prostate and the vesicles whether the discharge is little or great, following the subsidence of the process in the epididymis, for these structures are usually involved in the cases in which the infection passes to the epididymis. In support of this Brönnum has found the gonococcus in the secretion of the seminal vesicle on the same

side as the inflamed epididymis in eighty per cent. of the cases and in the other twenty per cent. leucocytes without that organism.

As a rule, I have begun the treatment of these structures by massage and deep urethral injections in about two weeks after operation.

Two patients who developed the disease in the organ of the opposite side, did not return after the operation for treatment of the infection remaining in the genital tract, because the symptoms immediately following the operation were so slight that they did not believe it to be necessary.

In four cases I combined the Belfield procedure of opening the vas together with the epididymotomy. These cases did not show results differing in any striking way from those in which this operation was not done.

In regard to the duration and occurrence of induration remaining in the epididymis after operation, I have seldom seen it disappear in less than two months, but the cases observed several months after the operation do not present the discrete indurated sclerotic areas in the globus major or minor which are discovered as a sequelæ of epididymitis in which the operation is not done.

In no instance of which I have had knowledge has there been a recurrence of the disease in the epididymis operated upon.

In my series I have operated bilaterally in six cases. Two of the patients had no further treatment after the first epididymotomy and developed the disease on the opposite side. Two owe their infection on the opposite side to a newly acquired infection after all symptoms of the previous infection has disappeared, and two developed the disease while under treatment. It is a noteworthy fact that the two patients acquiring the new infection developed the disease in the epididymis not at first affected and operated upon.

Fortunately I have been able to make observations in regard to the presence of spermatozoa in all of these cases. One of this group was married five years ago and has two children. Another has been married over four years and has two children. The seminal fluid from two others has been examined, it being collected in a cundom during sexual intercourse. Both patients show numerous living spermatozoa. Two others have had no intercourse and the fluids obtained by massage of the vesicles show no spermatozoa. One of these patients was operated upon the second time four years ago. The last examination of the massage fluid being two months after the last operation, at which time he still had a slight discharge. I have been unable to locate him for examination at this time. The other patient showing no spermatozoa in the massage fluid is still under treatment for disease of the prostate and vesicles. It is of interest to note that the massage fluid, from the two patients showing living spermatozoa in the seminal fluid collected in the cundom, also showed no spermatozoa, while they were numerous in the fluid collected during the sexual act.

In regard to the pathology of the condition, it is well known that the process is most active in one part of the epididymis, most often in the tail or globus minor and next most frequently in the head or globus major, while the process may sometimes involve the whole appendage.

It has been observed clinically that the inflammatory exudate resolves without abscess formation. It has also been observed that a secondary hydrocele dependent upon the inflammation in the epididymis occurs in most of the cases. In the reparative process, connective tissue changes take place resulting in hard nodules at the site of the acute process. These changes are usually permanent and may occlude the seminiferous tubules or canals of the epididymis, so that the spermatozoa cannot escape or are impaired in vitality in so doing. When both epididymes are involved sterility may

result. Buzla, in this connection states that an investigation of the soldiers of the German army showed that forty-one and seven-tenths per cent. of those who had bilateral epididymitis, were childless. Ligeois (Kocher) found in twenty-eight cases that after bilateral epididymitis, spermatozoa were absent in twenty-one.

For the purpose of histological study, pieces of the inflamed areas have been removed in some of my cases. These specimens were studied by Dr. F. W. Mallory, director of the Pathological Department of the Boston City Hospital. The pathological histology varies with the duration of the disease. In the early phases—within three days—the ducts are distended and filled with polymorphonuclear leucocytes. Among them are also phagocytic endothelial leucocytes. In places the lining epithelium is destroyed and the exudation is directly continuous with an extensive infiltration of connective tissue with similar leucocytes. In places the tissue has been destroyed and dissolved so that small abscesses exist. At the periphery of the acute process there is some infiltration with lymphocytes and some proliferation of fibroblasts. Within some of the polymorphonuclear leucocytes are flattened diplococci which are shown to be Gram negative.

In a later stage of the disease there is shown a fewer number of polymorphonuclear leucocytes in the lumina of the ducts. The inter-tubular connective tissue is much increased in amount and is infiltrated in places with lymphocytes. A few of the leucocytes even in the instances in which the tissue has been taken as late as the end of ten days, after treatment Gram negative diplococci in leucocytes have been found.

Summary: In summarizing I wish to state that I believe that epididymotomy offers the best means of ending acute gonorrhœal epididymitis and allaying the symptoms dependent upon this pathological condition. In consequense of this the convalescence is materially shortened. The fact that re-

current epididymitis has never been known to take place in an organ operated upon is significant and important. The small series of cases operated upon in which the disease was bilateral, show a relatively high percentage not becoming sterile which is an important factor in support of this form of treatment.

ABSCESS OF THE TESTICLE

By J. Dellinger Barney, M. D., of Boston, Mass.

As an occasional complication in various diseases, such as typhoid fever, glanders, syphilis, tonsillitis, smallpox and mumps, or as a sequel to some septic process elsewhere in the body, acute orchitis, with or without abscess formation, has been recognized from early times. But as a primary disease, without a demonstrable focus from which it might arise, abscess of the testicle is of great rarity. It is this type of orchitis which we propose to discuss. We wish further to make it clear that we are dealing here only with abscess of the testicle, and not of the epididymis.

Although, so far as we are aware, the records of the Massachusetts General Hospital contain no undoubted example of this type of orchitis, except the one to be reported, the writer has been fortunate enough to see two others in his own practice. In a somewhat scanty literature on the subject we have met with only two or three similar cases.

Case I. A. P., sixty-two years old, married, builder. Admitted to the Genito-Urinary Service at the Massachusetts General Hospital on December 8th, 1912.

Family history and past history negative except as given below. Alcohol to excess as a young man. No alcohol for many years. Strenuously denies venereal disease.

When a boy he had a swelling of the left side of the scrotum, not very painful or tender, and of a few days' duration. Another similar attack fifteen months ago, lasting two or three days. No known cause. These attacks were not associated with urethral discharge or urinary symptoms.

October 18th, 1912, the patient caught a severe cold. He developed much frequency of urination, every two or three hours by day, every hour by night. Considerable dysuria and tenesmus, but no difficulty of urination or retention. Says the urine was cloudy. After straining at the end of micturi-

tion patient noticed a discharge from the meatus. None between times. Urinary symptoms subsided in about two weeks.

Coincident with the disappearance of the urinary symptoms, which was about three weeks ago, patient noted a swelling of the left scrotum and this has steadily increased in size and tenderness. Very little pain till recently. Now the pain is heavy, dull and dragging. Frequency of urination is five or six times by day, three or four times by night. Weight two months ago 212, now 195 pounds. No headache or vomiting.

Other than the condition of the left scrotum, physical examination, including prostate and vesicles, showed absolutely nothing, the only points worth noting being the presence of an extensive pyorrhœa alveolaris, and a considerable redness of the throat. The temperature at time of entrance was 98.8° F. Systolic blood pressure was 165 mm. of mercury. The Wasserman reaction and the gonococcus fixation test were negative.

The urine was clear and sparkling, contained no shreds or albumen, and was sterile to culture. Guinea pigs inoculated with it were reported later as negative for tuberculosis.

The penis and right side of the scrotum were normal. The left side of the scrotum presented as a large, rounded tumor, about four inches in diameter, the swelling extending well up into the inguinal canal. Except on the anterior surface the skin was much thickened and brawny. Anteriorly, the tumor was fluctuant, with red, shiny, adherent skin. The tumor was smooth, elastic, and moderately tender. Testis and epididymis could not be distinguished. The whole spermatic cord was much thickened, the vas itself not being identified. Dr. Hugh Cabot, who saw the case with me, made a diagnosis of epididymitis with abscess formation.

Immediate operation was advised and performed by the writer. The fluctuant area of the tumor was incised with the escape of about four ounces of thick, yellow, odorless pus, mixed with necrotic tissue. This pus showed in pure culture

PLATE XXVIII.—Presented by Dr. J. D. Barney

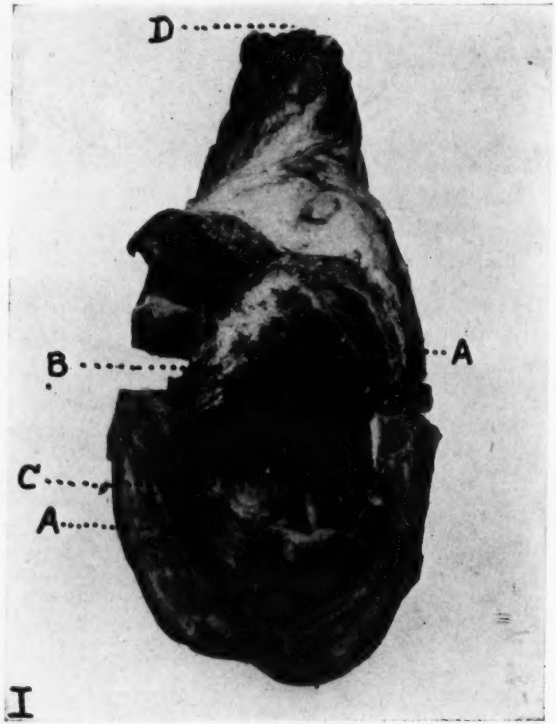


Fig. 1. Anterior view

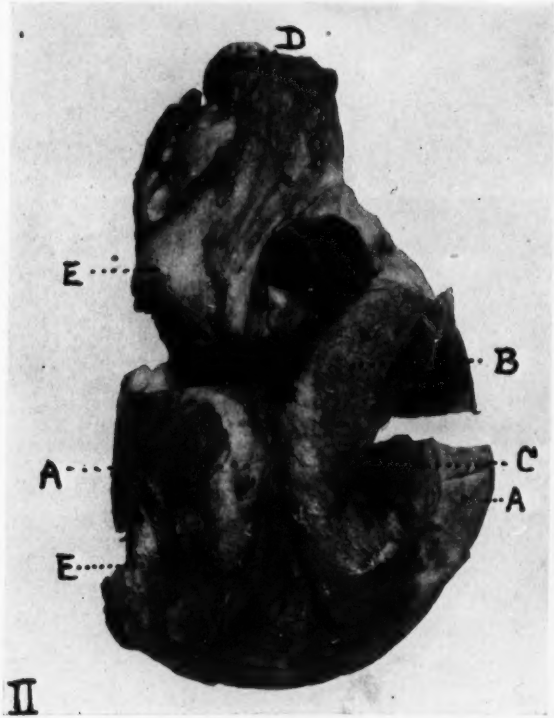


Fig. 2. Lateral view

A.—Thickened tunica. B.—Remains of wall of testicle. C.—Abcess cavity in testicle. D.—Spermatic cord. E.—Epididymis. (*Photographs by L. S. Brown.*)

the bacillus mucosus capsulatus and the streptococcus. Exploration with the finger showed that this pus came, not from the tunica vaginalis, which had not been opened, but from the surrounding tissues, which were sloughing and necrotic. The greatly thickened tunica was then opened with the escape of two or three ounces of thick, yellow pus, mixed with necrotic tissue in which were seminiferous tubules. This pus contained the bacillus mucosus capsulatus in pure culture. Attempts to separate tunica from testis revealed dense adhesions between them. The testicle now presented in the incision and was found to contain an abscess cavity the size of an English walnut, from which still more pus and necrotic testicular tissue could be expressed. The epididymis was not seen, but was felt posteriorly, thickened and indurated. The whole spermatic cord was much thickened. This was tied off in sections and divided near the external inguinal ring, thus removing, en masse, testicle, epididymis, and tunica vaginalis. (See Plate XXVIII). In the cut section the vas appeared to be normal. The inner aspect of the scrotal wall, which was very necrotic, was then thoroughly curetted, and the cavity swabbed with tincture of iodine.

Convalescence was uneventful, and the patient left the hospital ten days later.

He came to the Out Patient Department several times a week for dressings. The wound was entirely healed January 17th, 1913. On January 24th he returned with a profuse urethral discharge of about twenty-four hours' duration. There had been no coitus since October. Urination was four or five times day and night, and there was considerable dysuria. The urine was cloudy throughout and contained a few shreds. Smears of the urethral discharge showed much pus and many large Gram positive intra and extracellular cocci. No Gram negative organisms were seen. A culture of this pus showed a profuse growth of Gram positive bacilli and cocci. No gonococci were found. Four days later the

urethral discharge and the symptoms had subsided and the urine was perfectly clear and sparkling.

It is possible that the organisms found in the abscess and in the subsequent urethral discharge were identical, but unfortunately no steps were taken to compare them.

Sections of the testicle, at the points shown in the photographs (Figs. I and II) were examined by my friend, Dr. S. B. Wolbach, Assistant Professor of Bacteriology at the Harvard Medical School. We wish here to express our gratitude for his courtesy. His report is as follows:

"Section through the wall of an abscess of the testicle and includes testicular tissue and tunica albuginea. (Plate XXIX, Fig. I). The border lining the abscess cavity in the testicle contains a few small masses of necrotic material and in a few places, springing from the interstitial tissue, are small areas of granulation tissue. The tubules in the abscess wall are flattened and distorted. The germinal epithelium shows various stages of atrophy to complete disappearance. The cells of the tubules are represented by thick convoluted bands of hyaline fibrous tissue. The interstitial tissue throughout the wall of the abscess shows connective tissue increase and the formation of new capillaries. The tubules contain an occasional migrating polymorphonuclear leucocyte. The fibrosed interstitial tissue is everywhere infiltrated with polymorphonuclear leucocytes, lymphoid and plasma cells. The external border of the tunica is very much injected; in places there are small hæmorrhages. It is infiltrated with polymorphonuclear leucocytes, lymphoid and plasma cells. At one end of the section, involving the tunica and the testicular tissue, is an abscess cavity lined with granulation tissue and necrotic material. The necrosis has extended irregularly into the substance of the testicle, following the interstitial tissue. This abscess cavity is apparently at the reflection of the tunica vaginalis upon the testicle. There are smaller abscess cavities in the greatly thickened and fibrosed tunica vaginalis.

There is nothing distinctive in the pathological process

PLATE XXIX—Presented by DR. J. D. BARNEY

Fig. 1. Microphotograph (13 diameters) of section of abscess wall. Upper edge of section shows abscess wall; lower edge shows tunica. (*Photograph by L. S. Brown.*)

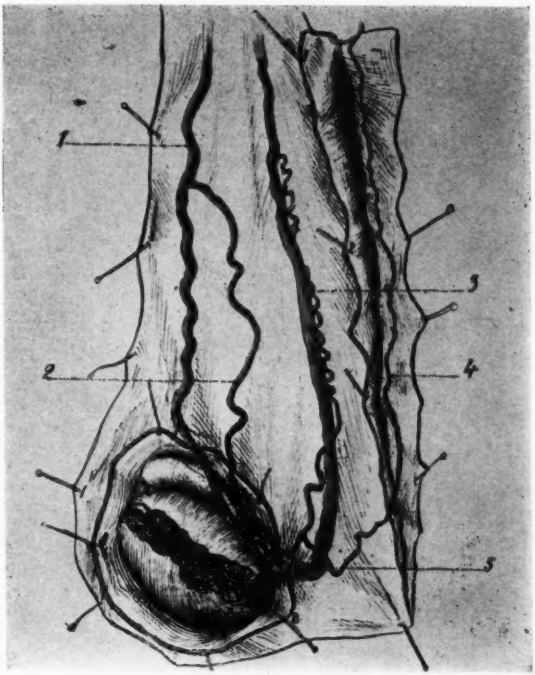


Fig. 2. Type I. 1,—Spermatic artery; 2,—Epididymal branch of the spermatic; 3,—Deferential artery; 4,—Funicular artery; 5,—Epididymo-funiculo-deferential anastomosis in form of T. (*Photograph by L. S. Brown, after Picque and Worms.*)

represented by this section. The changes are such as might be found in the tissues surrounding an abscess due to any of the pyogenic organisms. The process has been extending by way of the interstitial tissue. The changes in the tubules are largely due to pressure and subsequent atrophy, except where they are totally necrotic through involvement in the abscess cavity."

The two following cases were seen by the writer in his own practice.

Case II. H. K. H., thirty years old, single. Referred by Dr. A. J. Halpin, of Lowell, Mass., February 13th, 1912, for chronic prostatitis.

The patient had had gonorrhœa about a year previously. Six months later the left epididymis became involved. Since this he has had prostatic massage, irrigations and sounds regularly every week. The urine was clear with a few shreds, there was no urethral discharge, but there was a little pus in the prostatic secretion. The left epididymis was slightly thickened. After one or two visits the patient stopped coming. Two weeks later I was called to see him. On the day after his last visit the left side of the scrotum became tender, painful and swollen. The condition rapidly grew much worse. There was marked constitutional disturbance, evidently much fever, and great pain. There had been no urethral discharge or urinary symptoms.

When seen by me the patient looked very sick and had evidently lost much weight. The left side of the scrotum was much enlarged, red, indurated and brawny. Anteriorly the tumor was fluctuant. The vas was moderately thickened. Nothing abnormal was made out in the right side of the scrotum or in the prostate or vesicles. No discharge could be milked from the urethra. The urine was not examined.

The fluctuant area was incised with the escape of about one ounce of thick, yellow pus, containing the colon bacillus in pure culture. Testicular tissue, necrosis and sloughing, appeared in the wound. There were many strong adhesions

between the layers of the tunica vaginalis. On separating these the epididymis was found to be essentially normal in size and consistency. The whole lower half of the testicle was involved in an abscess leaving a cavity around which was a dense tough yellowish wall. The upper half of the testis appeared normal in color and consistency, and, together with the epididymis, was left behind in the hope of saving it. The necrotic tissues were carefully curetted and the wound drained.

Convalescence was uneventful, except that during it the upper half of the testicle sloughed out leaving behind an epididymis, which up to date, seems perfectly normal.

Case III. G. B., thirty-five years old, single, lawyer. Referred to the writer on December 31st, 1910, by Dr. John W. Dewis, of Boston.

Gonorrhœa several times with a bilateral epididymitis four years previously.

About four weeks ago the right side of the scrotum became swollen and painful. Patient was confined to his bed for several days on account of pain and tenderness. A few days ago an abscess formed in the front of the scrotum causing much pain. There has been no discharge from the urethra and no abnormality of micturition.

The patient looked sick and haggard. The right side of the scrotum was found to be much enlarged, very œdematous, indurated and reddened. In front, near the raphe, there was a soft fluctuant area. The scrotal contents could not be made out. The left testis and epididymis were normal.

Orchidectomy was performed by the writer. The whole spermatic cord was much thickened and matted together, but the vas itself was not enlarged. Incision of the fluctuant area in the scrotum allowed the escape of much thick pus, mixed with necrotic testicular tissue. The tunica was much thickened and adherent to the testicle anteriorly. The latter is involved in an abscess which invades chiefly its upper half.

The epididymis did not seem to be inflamed. Unfortunately no cultures were taken.

That the testicle, even in the presence of an actively suppurating epididymis, is extremely resistant to bacterial invasion we are all aware. Its power to recover from severe infection, as for example tuberculosis, after removal of the primary focus in the epididymis has been shown by the writer in his studies of epididymal tuberculosis. It would seem, therefore, that Nature had planned well to preserve to the last an organ which is of prime importance, not only for her welfare, but also for that of its owner.

The defense of this vital organ is threefold, consisting on the one hand of its dense and intimately applied tunica albuginea, on the other of its rich and elaborate blood supply, and finally, we must regard the rich lymphatic network with which it is surrounded and permeated (Testut and others) as being a protective factor of no little value. Also we regard it as possible that the little understood, but none the less recognized, internal secretion of the testicle may contribute more or less to its comparative immunity. The value of the albuginea as a protective shield was recognized and described years ago by Gendrin, whose opinion was also shared by Curling. The latter says:

"When the contiguous organ or adjacent part is of a different structure from that of the cellular tissue, the extension of the inflammation inward is checked. Thus in the case of the inflamed tunica vaginalis the cellular tissue readily transmits the morbid action to the epididymis, but the tunica albuginea arrests its progress to the body of the testicle."

The elaborate blood supply already mentioned is to be regarded as a two edged sword. Not only can it maintain such a high state of nutrition in the testicle that incoming bacteria are readily discouraged, but obviously it also serves as the high road along which these organisms can travel. This rich vascularity of the organ, a kindly provision of Nature not only for the salvation of the reckless surgeon, but

also for the testicle itself, has been demonstrated by Picque and Worms, who have perfected and confirmed the work of many earlier investigators, in a large series of careful dissections of injected human specimens. They have shown constant, but slightly variable anastomoses between the spermatic, the deferential and the funicular arteries (the latter running in the walls of the tunica vaginalis). These variations fall roughly into three groups, Plate XXIX, Fig. 2 and Plate XXX, Figs. 1 and 2. In each however, it is clear that blood is conveyed to the testicle by the three different arteries already mentioned, any one or two of which may be, and often are, destroyed without harm to the organ.

If now we are to regard the rich blood supply of the testicle not only as a means of defense, but also as the conveyer of infectious organisms we may well ask why is not the one function of the blood stream nullified by the other? The question is partially answered by the statement of Dr. Belfield that the testicle, like the kidney, is an excretory organ. In a recent article he says: " . . . . while the kidney is provided with a new and private sewer, the ureter, the testis continues to use the frog's old urinary duct, now called epididymis and vas deferens. This excretory function of the testicle and its duct illumines both its intimate alliance with the kidney and its frequent infection from the blood. . . . . The recognition of the testis as an excretory organ illumines the frequent invasion of its tubules by mumps, typhoid and colon bacilli, spirochæte pallida, and other blood infection."

For our purposes we must go farther and attribute to the testicle, not only an excretory, but also a selective function. In this way only can we explain its freedom from invasion by the gonococcus, and to a certain extent by the tubercle bacillus. For these two organisms at least, and especially the first, the testicular soil is inimical. On the other hand, the tissues of the testis seem, on occasion, to offer favorable conditions for the growth of the organisms of typhoid fever, mumps, glanders, and syphilis. These diseases rarely, if ever,

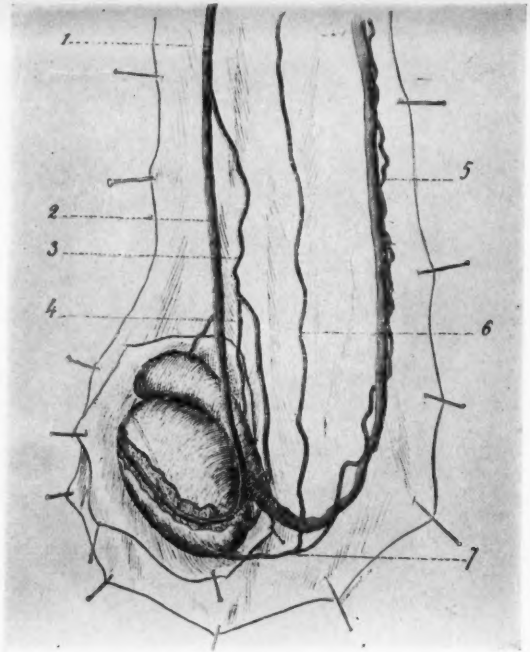


Fig. 1

Type II. 1,—Spermatic artery (main trunk;) 2,—Internal spermatic artery; 3,—External spermatic artery; 4,—Epididymal branch; 5,—Deferential artery; 6,—Funicular artery. 7,—Spermato-funiculo-deferential anastomsis in form of T. (*Photograph by L. S. Brown, after Picque and Worms.*)

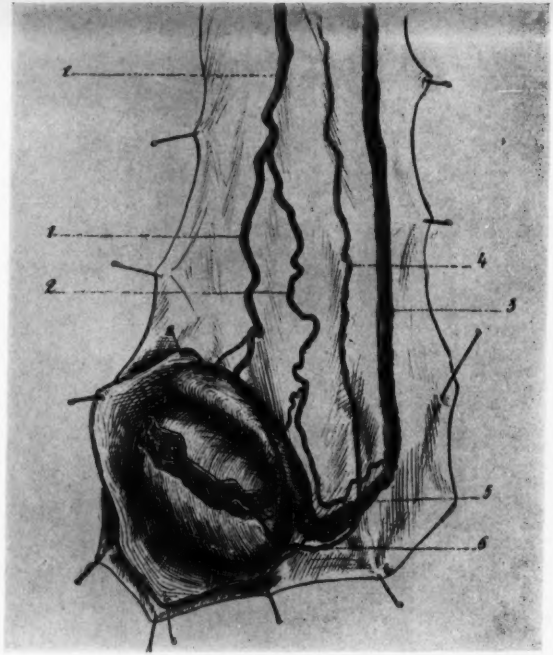


Fig. 2

Type III. 1,—Spermatic artery; 2,—Epididymal branch of spermatic; 3,—Deferential artery; 4,—Funicular artery; 5,—Anastomosis between epididymal branch and deferential artery; 6,—Anastomosis between a testicular branch of spermatic and funicular artery. (*Photograph by L. S. Brown, after Picque and Worms.*)

attack the epididymis, and then only late in the disease. Here again is evidence of a selective action.

The pyogenic organisms such as the colon bacillus, the bacillus mucosus capsulatus, and the staphylococcus aureus, find conditions favorable for their growth in testis as well as in epididymis. In this group we can also place the tubercle bacillus, for, as we are all aware, while it attacks the epididymis primarily, it may later invade the testicle, flourish there in a half hearted manner, and disappear after the removal of the primary focus.

It is our conviction that organisms of various types may and do circulate in the blood stream at various times, and under certain conditions. To the fact that they find lodgment in certain organs and tissues, when circumstances are favorable, is due the occupancy of most of the beds in our hospitals.

It is clear that these organisms find their way into the testis and epididymis as freely and as frequently as into other organs, perhaps more so, owing to the fact that their main blood supply, the spermatic arteries, take origin from the aorta, which might reasonably be called the distributing center. But we have seen (Plate XXIX, Fig. 2 and Plate XXX) that the circulation of the testicle and epididymis is not only very rich, but also is so arranged that organisms passing through any one of the three main arteries have free access to both organs, more especially the testicle. This being the case, we must look to that selective action of each organ already discussed, to explain the invasion of testicle by one organism, of epididymis by another, and of either or both organs by a third. Furthermore, we must ascribe infection of the epididymis, more frequent by far than that of the testicle, to a less active resistance, this being due perhaps, to the difference in the blood supply of the two organs, which we have seen exists, and also to the comparative poverty of the epididymis in its lymphatic circulation.

What evidence have we that the infection of the testicle in the three cases reported occurred, not by way of the vas

deferens, not through the lymphatics, but by way of the blood stream?

First, Esmonet, in 1902, showed that the testicle could be infected much more easily and frequently by injection of organisms (tubercle bacilli) into the general circulation through the aorta than through the vas deferens, even though a condition of stasis was produced by ligature of that structure. The more recent work of Walker has confirmed this view. Speaking of his experimental production of tuberculosis of the testicle in guinea pigs he says:

"In those cases in which the animals had received injections into the aorta, and had been killed within a short time afterwards, I found in one gland several small capillaries containing tubercle bacilli, and in another I observed very young tubercles close to the blood vessels. It is presumable from this that the organisms penetrate the walls and form a tubercle in the immediately surrounding tissues."

What applies to the tubercle bacillus may apply as well to other organisms. But it must not be forgotten that in clinical material, owing to the length of time which generally elapses from onset of disease to time of operation, the pathologist is obliged to read the story backwards, a feat which he is either unwilling or unable to perform.

Secondly, it is now universally acknowledged that renal tuberculosis occurs, not by ascending infection through the ureter from the bladder, but by a hæmatogenous or lymphatic route. In other words infectious processes tend to follow the natural route of the secretions or excretions of the organs involved. Thus it is also acknowledged by most that in genital tuberculosis the epididymis is primarily attacked, prostatic involvement being secondary. Thus the tubercle bacillus follows the current in the vas deferens from epididymis to prostate. Even in the frequent examples of involvement of the second epididymis shortly after the involvement of the first side there is ample experimental and clinical evidence to

show that this too is not a deferential but a hæmatogenous, or, in certain cases, a lymphatic transmission of bacilli.

Thirdly, in many infections of the testicle by the typhoid bacillus, as well as by other organisms, repeated examination of the urine microscopically and bacteriologically has revealed no bacteria. The infection is clearly hæmatogenous, although in a few cases note has been made of the primary involvement of the whole spermatic cord or of the vas, indicating possibly a migration of organisms through the lymphatics.

And so it must be regarded in our first case, if not in the others as well. All the diagnostic means at our disposal failed to reveal a focus of infection in the body, not even in the genital or urinary tract, although it seems probable that the patient had had an epididymitis and possibly a prostatitis, perhaps of gonorrhœal origin. The patient had a severe pyorrhœa alveolaris and a reddened pharynx. Possibly a culture from these two points would have thrown light on the matter. The infection of the testicle in the second case with the colon bacillus is equally obscure and purely a matter of speculation. But in both it seems clear that the infection was hæmatogenous, although we cannot exclude a lymphatic origin. This view is strengthened in the first case at least, by the report of the pathologist who finds the process to have extended by way of the interstitial tissue, a fact which suggests a blood borne infection. The work of Walker, just referred to, seems to bear out this belief.

Reduced to its lowest terms this discussion summarizes as follows:

1. The testicle is protected from infection by its tunica albuginea on the one hand, and by its rich blood and lymph supply on the other.

2. Arguing from an embryologic viewpoint the testicle, like the kidney, may be regarded as an excretory organ.

3. As blood borne organisms reach epididymis and testicle with equal freedom and frequency, it would appear

that the latter has selective function, rejecting certain organisms and harboring others.

4. Most of the testicular infections are hæmatogenous. A few are probably lymphatic in origin.

5. Infection of the testicle, resulting in abscess and without epididymal involvement is exceedingly rare.

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VASOSTOMY-RADIOGRAPHY OF THE SEMINAL DUCTS

By William T. Belfield, M. D., of Chicago, Ill.

1. Vas and vesicle usually accommodate from four to six c.c. of a non-irritant liquid, such as ten per cent. argyrol solution, injected through a scrotal vasostomy. None of the solution escapes through the ejaculatory duct until vas and vesicle are filled, because this exit is closed by a sphincter. This muscle yields to overfilling of the seminal ducts, the solution passing into the prostatic urethra and thence usually backward into the bladder, but occasionally forward into the anterior urethra, escaping at the meatus. An unlimited quantity of solution may be thus used to irrigate vas, vesicle, ejaculatory duct, prostatic urethra and utricle; and this irrigation may be repeated at the discretion of the operator.

2. For days after such filling of the seminal duct, peristalsis of vas and vesicle occurs, shown by the constant presence of argyrol in the urine, and sometimes demonstrable through the urethroscope as an intermittent discharge from the ejaculatory ducts. Since this occurs without subjective perception, peristalsis must be regarded as a normal function of the seminal, as it is known to be of the urinary, duct; and the prostatic urethra as the natural catchbasin for the seminal, as is the bladder for the urinary canal.

3. Retrograde urination, that is, the escape of urine through the vasostomy incision when a strong desire to urinate was resisted by the patient has been observed in two of my cases; in one of these, argyrol solution injected into the bladder was forced through the scrotal incision, proving the source and course of the clear fluid previously observed to issue from the cut. Each of these patients had suffered from frequently recurring epididymitis during several years following a gonorrhœa; in each the corresponding ejaculatory duct was patulous and easily catheterized. Although this

passage of urine from the urethra into the vas seems to have been hitherto unobserved except after operations upon the prostate (by Voelker in two operative cases) yet it seems probable that such retrograde passage of urine into the seminal duct may be the not infrequent cause of recurrent epididymitis and vesiculitis following gonorrhœa, as in these cases.

4. The normal peristalsis of the seminal duct explains certain hitherto obscure phenomena, including the phosphaturia so frequent in the subjects of sexual neurasthenia. These men usually exhibit an infection of the vesicles with hypersecretion and active peristalsis of their contents. Since the vesicular secretion is known to precipitate lime salts when mixed with urine, it is apparent that the constant discharge of such secretion into the prostatic urethra and thence into the bladder, can throw the lime compounds of the urine out of solution in the bladder, causing phosphaturia. That this was the correct explanation in two patients I proved by catheterizing both ureters while the urine in the bladder was cloudy from undissolved lime salts; from these catheters clear urine escaped. Blood and pus mixed with urine may be derived from the vesicles.

5. Anastomoses between the dilated extremity of the vas (ampulla) and the associated vesicle are not rare. Since these must furnish direct passage of spermatozoa into the vesicle, this observation seems to prove that the vesicles may be not only secretory organs but also reservoirs for spermatozoa, contrary to the current assumption.

6. Experience with vasostomy has shown that sterility may be due to occlusions not alone of the epididymis, but also of the vas and of the ejaculatory duct; also that the absence of spermatozoa from the emitted fluid is sometimes due not to an obstruction of the ducts but to arrest of the spermatogenic function of the testis through an infectious disease, such as mumps or typhoid fever.

PLATE XXXI.—Presented by Dr. W. T. Belfield

Fig. 1
Pus infection of vesicle; gleet.

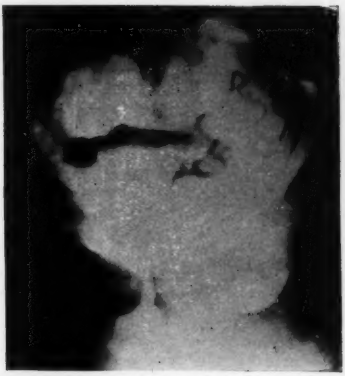

Fig. 3
Pus tube on right; tortuous vas on left side.

Fig. 2
Colon bacillus infection of vesicles. Chronic toxemia.

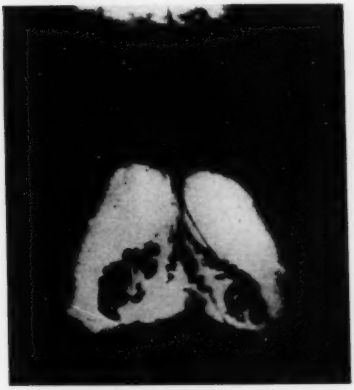

Fig. 4
Bilateral gonococcus infection; stiletted catheter in right ureter.

VASOSTOMY—RADIOGRAPHY OF THE SEMINAL DUCTS

Vasa deferentia, seminal vesicles and ejaculatory ducts injected with collargol solution through vasostomy (*Radiograms by Dr. Potter and Mr. Bell, Presbyterian Hospital; Drs. Case and Van Horn, St. Luke's Hospital, Chicago.*)

7. The vesicle may be converted into a pus sac, a pyovesiculosis.

8. In at least two cases a chronic colon bacillus infection of the seminal duct has caused chronic toxæmia, shown by continuous temperature and progressive loss of weight, exceeding twenty pounds in one case. In both patients irrigation of the seminal ducts through vasostomy was followed by rapid return to normal temperature and gradual recovery of usual weight, as well as disappearance of a chronic gleety discharge sometimes tinged with blood.

9. The juxtaposition of ureter and infected vesicle, already shown to be capable of causing obstruction of the ureter and consequent damage to the associated kidney, is illustrated in some of my radiograms. The ureter is shown to lie approximately over the central axis of the vesicle; the usual text-book illustrations, made from dissections of the dead subject, evidently do not represent the relations existing in the living body.

Dr. E. Wood Ruggles, of Rochester, N. Y.: I have never used any operative treatment in cases of epididymitis, but in regard to the statement as to the cure of gonorrhœa through this operation, I have become accustomed to tell my patients that in my experience in one case out of three, recovery follows epididymitis and the results do not seem to be much if any better after operative treatment.

I have one interesting case to relate in regard to sterility, that of a man who had been married for four years and was sterile. He would have an erection as long as he proceeded with intercourse, but he never had an orgasm. On examining him I found that he had a seminal vesiculitis with some living spermatozoa.

I treated him for a while by massage and, finding that he still had no orgasm or discharge of semen, conceived the idea of impregnating the wife with his spermatozoa. He readily agreed and brought her for the treatment. After massage I had him urinate in a glass, and with an ordinary urethral syringe took up some of the seminal fluid from the bottom of the urine and injected it into the vagina. This fluid showed fairly active spermatozoa microscopically. This was performed twice, immediately following menstruation, without success.

I then had a long narrow metal tube with the curve of a uterine sound made and attached to a metal syringe. These were kept in normal salt solution at blood temperature. Immediately upon obtaining seminal fluid by massage I took up a small amount with the syringe and injected it into the uterine cavity. Only a trifling colic resulted. This also was performed twice but without success. Had the attempt succeeded my endeavor to produce "immaculate conception" would not be related in this cursory manner.

Dr. Francis R. Hagner, of Washington: I have listened to these papers with a great deal of interest. Dr. Barney has done a good deal towards clearing up the pathology of these conditions. We have had one case of abscess of the testicle. This followed a calculus of the bladder with colon infection. This man had an abscess of the testicle, but he also had an abscess of the epididymis, and the tunica was filled with stinking pus. It was not a solitary abscess, but there were miliary abscesses all through the testicle.

I am, of course, very much interested in the paper of Dr. Cunningham. He speaks of the recovery of the urethral infection in these cases after operation. I noticed that on the first cases operated on, but never made any mention of it because I was afraid of being a little too en-

thusiastic; but as men began to do the operation, others noted the same thing. I do not mean to say that every case that has a puncture of the epididymis, gets rid of a chronic gonorrhœa, but there is no question that there is a certain percentage of cases that do get perfectly well very shortly after the operation is done, and another advantage is that it enables you almost immediately after the operation to begin treatment of the vesicles and prostate, which we are often afraid to do after the palliative treatment of gonorrhœal epididymitis, because we are afraid of bringing on another acute exacerbation.

I have been using the method of closing the scrotum that Dr. Cunningham described for nearly a year, and feel it is by far the best method of closing any wound in the scrotum. There is less infiltration, it stops hæmorrhage absolutely, and hæmatomata do not form. We also use it in varicocele and hydrocele operations.

Dr. Cunningham speaks of pus in sixty-eight per cent. of cases. Some of my good friends say that practically none of their cases have pus. We have found pus in approximately eighty per cent. of cases. Of course, most of the cases I have operated on have been severe cases. I operated on a case in Boston that was a mild case, and stated that I was not sure that pus would be present, but it was found and on examination it contained numerous gonococci. It is absolutely impossible to tell whether pus is present until we get into the epididymis. Dr. Belfield some years ago said you could tell whether pus was present or not, because when it was present there would be infiltration and thickening of the skin. I have seen that when there was pus present, and also when it was not present.

I think it is an interesting fact that every one seems to be coming to believe as I do, that no organism is found in these cases except the gonococcus. In nearly a hundred cases we have never been able to demonstrate any other organism. In some of the cases we have not been able to demonstrate any organism, either in culture or on cover slips. In the last year or so I haven't been going into the bacteriology as carefully, because I was absolutely certain that there was no organism in these cases of acute epididymitis except the gonococcus.

We have operated on several cases where there were tender nodules and removed the nodules. They are unquestionably encysted abscesses. You do not find any pus, but they are composed of broken down material surrounded by a large mass of scar tissue.

We have had one case of recurrence this year after epididymotomy. In this case the patient left the hospital four days after operation, and came back on the fifth day with a recurrence. The epididymis became sore again, and was swollen. He stayed in the hospital three or four days and the swelling disappeared. This is the first case we have had where there has been any recurrence at all after this operation. The absence of recurrence was rather a trial to me in the beginning, because I felt that it was the strongest argument against the operation, because if these patients did not have recurrence there was probably occlusion of the epididymis. But I believe we will be able to dispel this impression.

The cases Dr. Cunningham has spoken of who were operated on for double gonorrhœal epididymitis are instructive. Two of them have children. Two others have live spermatozoa, and two others were not examined but I grant they are sterile. That is not any worse than we have without operation. The best statistics I have been able to find is forty per cent. We have operated on but four cases of double epididymitis. On two of those cases a second operation was done, one about a week and the other ten days after the onset of the second attack of epididymitis. Both had pus and both are sterile. Two other cases that came as soon as the epididymitis developed and insisted on being operated on, were operated on; no pus was found, and both of those men have live spermatozoa. Of course, this is rather an argument in favor of early operation in these cases.

In regard to pathology, Monad and Terrillon have the best description, and they claim that the lesion is principally peri-tubular, but the main lesion seems to be the infiltration outside of the tubules. For that reason I have been careful to puncture in these cases and not to cut. We know very well that in a punctured wound of the abdominal cavity, if there is no cut, simply a stab wound, often the intestines escape, and it would seem absolutely certain if a careful puncture is made that we do not injure the tubules of the epididymis. I use a little iridectomy knife, and when I find pus I simply cut along the parietal layer of the tunica vaginalis, and if that is retracted you can see the tubules. I use a blunt probe and work it down to the abscess and when it is withdrawn you will not see any cut surface of these tubules. I believe it is perfectly possible to pass the probe in without destroying the tubules, whereas if a free incision is made we are bound to destroy the continuity of the tubules.

If those gentlemen who argue against this operation would operate on acute cases they could not help feeling that it is a rational procedure. One case brought that very forcibly to mind, a man with beginning pain in the groin at eleven o'clock A. M., was examined and his vesicles were found thickened. I told him that he would have an epididymitis inside of twenty-four hours. At eleven o'clock that night he had his first pain. He was operated on fourteen hours after the initial pain, and we found three abscesses in the epididymis containing gonococci, and the three abscesses contained almost a drachm of pus. The relief is just as great whether pus is present or not, but I am sure if the gentlemen will palpate the epididymis carefully, pass a probe down to the point of thickening that they will find more pus in these cases than some of them seem to find.

Dr. Louis E. Schmidt, of Chicago: I have had experience with over a hundred cases. I have been inclined to select the cases, and in addition to that the operative procedures have been somewhat different. Most of them have been operated on according to Hagner, but in addition to that I occasionally do the regular Jabolet operation for hydrocele. If the body of the epididymis is particularly involved, I do not do this operation, but go in posteriorly without entering the tunica. I think it is well to make a distinction with these cases, because in those cases where the inflammation and swelling are enormous I am inclined to believe that you get the drainage, which is practically what you are looking for, without doing more damage than is necessary. In the severe cases if you go in in front I think the results are not quite as good. I always do in every case a vasostomy through a separate incision higher up in the scrotum.

Dr. W. T. Belfield, of Chicago: Incision into the epididymis and tunica vaginalis for the evacuation of gonorrhœal pus, must be credited to Escat, who reported to the French Urological Association and published in Guyon's *Annales,* in 1903, six cases of acute gonorrhœal epididymitis so treated. It is true that half a century earlier, Smith of London and Vidal of Paris practiced puncture of the inflamed epididymis for the relief of tension; but they did not know that pus might be found, and hence did not incise to find it. It is also true that Escat's procedure was practiced independently by Belfield and by Bazet, and published by them in 1905; and that their articles induced Hagner to adopt this treatment and publish his results in 1906. But none of us has added anything to Escat's operation except corroborative experience. To call

this "Hagner's operation" is to proclaim ignorance of current literature. Since the gonococcus and other bacteria reach the epididymis by way of the vas, such epididymitis proves prior infection of vas and vesicle. To incise the epididymis and neglect to medicate vas and vesicle by suitable irrigations, seems curiously irrational. We have learned to treat infections of the seminal duct at the prostatic urethra end: we are learning to treat them at the epididymis end; in time we shall probably discern the necessity for treating not only both ends of the duct but also the middle—the twenty inches of vas and vesicle which are already infected when the epididymis begins to swell.

Dr. Hugh H. Young, of Baltimore. I think all of us who have watched with interest and enthusiasm Dr. Hagner's work realize that in his first paper he made it very clear that the idea was not original; in fact, it had occurred to him as an original thing, but when he looked up the literature he had found it had been done many years ago in England and he mentioned it in the paper. The trouble is with the enthusiasm of his friends. He has published a long discarded operation, the value of which had long been lost sight of. He has shown the very great value of it, and the tendency is always to give the credit to the man who does real work in demonstrating the value of a procedure and gives it to the medical profession, rather than to an initial long forgotten discoverer. For instance, over a large part of the surgical world suprapubic prostatectomy is known as Freyer's operation. We know that Freyer did not originate the thing, and the only original thing he did was to do it a little more mutilatingly than the rest. In regard to the two-stage prostatectomy Lillienthal is given the credit; everyone here knows that men were doing it years before he ever published it. It is the man who brings a thing out most repeatedly and impresses it upon the medical profession who gets the credit for it.

Dr. Barney: I have little to add except that I think these cases of abscess of the testicle are rather more common than we are led to believe, due to lack of ability to make the diagnosis. They are diagnosed simply as abscess of the scrotum. A small incision is usually made, the abscess is emptied and we have no accurate means of determining whether it is in the testicle or epididymis. Discussion of the etiology must be on purely theoretical grounds.

Dr. Francis R. Hagner, of Washington: As Dr. Belfield has criticised the calling of epididymotomy the Hagner operation, I feel it is due me to state my position:

Dr. Young has defended me and I appreciate his kindness. In my first paper I spoke of the work of Smith in 1846 when they were making puncture through the skin of the scrotum for epididymitis. I made no mention of Bazet's work in my first paper as he had not published his cases at that time. In my second paper, I gave him full credit and acknowledged his priority of an open operation in these cases as he had done it a year before I had, although he did it in an entirely different way.

Before writing my first paper I had the literature thoroughly gone into by translators in the Surgeon General's Office and no report of Escat's work was given me and the first I have known of it is the statement of Dr. Belfield today. I have never called this the Hagner operation. I have never asked any of my friends to call it this and have never spoken of it as anything but epididymotomy.

I think the priority is the least important feature of the operation, it is a good thing and I believe it is so realized by every man who has had any experience with it.

WHEN IS THE TWO-STAGE PROSTATECTOMY INDICATED?

By James Pedersen, M. D., of New York City

ALL patients require more or less preparatory treatment before undergoing prostatectomy. A few require a good deal, rather than "more or less." This preparatory treatment is made necessary,—if not obligatory,—by one of three conditions, or a combination of them. These conditions are: First: Infection of the bladder; Second: renal insufficiency; and Third: cardio-vascular disease. In a measure, these are related and interdependent.

To relieve bladder infection and to improve kidney insufficiency, there is nothing more certain than free urinary drainage, plus free diuresis, sometimes with urinary antiseptics added. To benefit a bad cardio-vascular condition, good renal elimination and rest are essential. All these are compassed by cystostomy.

If now we see in cystostomy a potent means to highly desired ends, it will not be difficult to think of it as merely the logical extreme of the ideal preparatory treatment. Cystostomy thus viewed, as literally preparing the way for prostatectomy, does not appear superfluous in all cases, and the advantage of the so-called two-stage prostatectomy in some cases becomes established.

A surprising number of operators have recorded their approval of the procedure from personal experiences. My references give twelve, beginning with Nicoll in 1894 and coming down to the present. At least two discovered the advantages through having to perform an emergency cystotomy for intravesical hæmorrhage and over-distention with urine and clot. The end results of the eventual prostatectomy in those given unpromising cases were so surprisingly good, that a favorable conviction was forced upon the observer. Lang goes so far as to ask whether the two-stage operation

will not save the lives of those in whom prostatectomy has been hitherto contraindicated. Lilienthal says that it enables him to operate with a sense of security on any patient, no matter how old or feeble, and with the certainty that there will be less hæmorrhage. Pauchet advocates it whenever, expressed in one word, "the patient is to run a risk."

According to these authorities, the arguments for the two-stage prostatectomy are these:

1. It decreases the danger of sepsis by allaying the cystitis and reducing the overwhelming number of pathogenic bacteria in the bladder.

2. It relieves the kidneys of back pressure and improves their function.

3. It rests the bladder and allows it to recover its expulsive power.

4. It diminishes the hæmorrhage of the prostatectomy.

From their manifold experiences are deduced these indications:

1. Active and severe bladder infection.

2. Kidney infection.

3. Bad general condition, whether from chronic sepsis, chronic gastro-intestinal toxæmia and inanition, or threatened uræmia.

The period of drainage varies from a few days to several months, apparently depending somewhat upon the operator's predilection, but chiefly upon the local and general condition of the given patient. The aim is to restore the patient as nearly as possible to a condition of health in preparation for the radical operation.

If the drainage has to be continued for longer than a few days, the patient is allowed to be up and about, thus avoiding the deteriorating effect of confinement to bed noted in some asthenic elderly men.

The danger from a double anæsthesia is obviated by using local anæsthesia for the cystostomy, and gas for the prostatectomy. One operator (Kayser) performed the

enucleation after cocainizing the vesical mucosa. Another (Lanz) accomplished this second stage without any anæsthesia.

Mention should be added here of a small group of operators, comprising Fournier, André, Chetwood, and Bruce-Clark, who have made a suprapubic cystostomy the first stage and a perineal prostatectomy the second stage.

The following six cases from my personal experience are given in briefest outline.

Case I.—N. Seventy-three years old. Emaciated; very feeble. Advanced chronic cardio-vascular changes with associated chronic bronchitis and considerable expectoration. Mitral regurgitation, but compensation good. He came from a distance and almost collapsed while driving from the railroad station to the hospital. History of prostatic obstruction for years. Total retention, two years. Catheterization every five or six hours. Hæmaturia for several months, aggravated by catheterization. Urine foul and purulent.

After forty-eight hours of rest in and out of bed and of preparatory treatment, rapid suprapubic cystostomy under local anæsthesia. Slight shock when interior of bladder was palpated.

Prostatectomy ten days later, with removal of a calculus. Considerable bleeding. Tamponed prostatic cavity. Suprapubic drainage tube. Tube removed second day; tampon on the third day. Out of bed eleventh day. Indwelling catheter. Sinus not closed permanently for three months. Four months after operation, urine normal; residuum dr. i. Has gained eleven pounds.

Case II. K. Seventy years old. Small, spare, of feeble appearance; exhausted by worry and hard work. Œdema both legs, right especially. Began with pain four weeks ago. Some, even considerable, arteriosclerosis.

First prostatic symptoms seven years ago, usual frequency, urgency, tenesmus, and insidious retention, ending in chronic over-distension. Recovered by systematic catheter-

ization, without infection of bladder. All treatment was discontinued seven months later. No further bladder symptoms, and no treatment since.

Now six years later comes complaining of incontinence. Extreme over-distension present for the second time. Systematic catheterization of no avail. After usual preparatory treatment, cystostomy April 23rd, 1912. Prostatectomy six days later. Enucleation easy. Out of bed on twelfth day. Primary union in sutured portion. Granulation of balance slow, due to generally feeble condition. Satisfactory recovery of bladder function. Residuum today only dr. ii.

Case III. R. Sixty-eight years old. Thin, spare, very anæmic; supersensitive. Arteriosclerosis marked.

Prostatic symptoms began four years before he came under observation, and had presented the usual variations in nature, occurrence, and severity. Polyuria the rule; very turbid, sometimes less so. Evidently pyelitis of long standing. Bladder over-distended for an unknown length of time, with from sixteen to twenty-one ounces. In appearance, a sick man.

Systematic catheterization and careful attention to bowels and circulation. Cystoscopy showed purulent urine from left ureter, and discovered a small diverticulum in posterior wall. Cystostomy Nov. 17th, 1910. Drainage with practically no leakage was continued for two weeks. Improvement in general condition very striking. Dullness and apathy disappeared. Appetite returned and increased rapidly. Nutrition improved. Urine cleared up perceptibly.

Prostatectomy December 1st, 1910. Sat up on sixth day. Began to walk about on tenth day. In good health since.

Case IV. R. Eighty years old. Very active, energetic, and mentally alert. General condition good for his age. Some cardiac impairment.

His first retention, February 1st, 1912. Prostate large and so hard as to suggest malignancy. This fact, his age, and circulatory condition, taken together, led me to temporize.

Catheter life was successfully started, and was continued without infection of the bladder. At the end of four months, he decided to take the chances rather than be dependent on the catheter.

Cystostomy, under gas, June 12th, 1912. Moderately dense adhesions were encountered when coming down upon the summit of bladder. These must have resulted from an injury he had sustained four years before, when he was knocked down by an auto and variously cut and contused. It is probable that a minute extraperitoneal rupture of bladder occurred at that time and left its mark in the form of the aforesaid adhesions.

Prostatectomy, under gas, three days later. Dense and rigid. Considerable force required; nevertheless, very little bleeding. No intravesical packing. Three days after operation, while still in bed, sudden dyspnœa and syncope. (Had been on strychnia since the cystostomy). Cardiac stimulants given, and he soon recovered from the syncope and dyspnœa. Out of bed on seventh day. Sinus closed; "all urine via urethra" on sixteenth day. Home on the eighteenth.

Case V. P. Seventy years old. Prostatic symptoms about two years.

Bladder very sensitive and irritable. Capacity only oz. iiiss. No calculus. Foul, purulent urine. General condition, fair; but marked cardio-vascular changes. Heart action intermittent and irregular.

December 13th, 1912. Cystostomy. Bladder wall much thickened. m.m., deep purplish red. Suprapubic tube, having been carefully stitched in, gave almost perfect drainage, but apparently in too far in spite of precautions to the contrary. Considerable pain and tenesmus; required anodyne. Therefore removed tube at end of third day. Pain ceased. Allowed urine to escape passively two days longer.

Prostatectomy December 18th, 1912. Unusually little bleeding. Uneventful convalescence. Returned home December 31st,—thirteenth day.

Though tube drainage had to be discontinued out of deference to the patient's comfort, we do not think the case argues against the two-stage operation. Drainage was maintained a total of five days after all.

Case VI. L. Seventy-five years old. Tall and of large frame. Somewhat emaciated. Markedly anæmic. Advanced arteriosclerosis. Obviously some impairment of mental function, probably to be classed as paresis in early stage. Slight prostatic symptoms the past year. Two attacks of retention; first, a year ago; second, a month ago. Since the latter, his physician has had him use the catheter. Bladder now infected; very sensitive. Frequency and tenesmus. Odorous purulent urine, last portion almost clear pus. Residual oz. iv–viss.

Systematic catheterism and irrigation. Very little improvement. Cystoscopy. Very large prostate (though urethral length only eight and a half inches). No calculus.

April 16th, 1910. Cystostomy, painstakingly performed to secure advantageously situated fistula for prolonged, if not permanent suprapubic drainage, in case it were decided for some reason not to perform the second stage.

Patient's mental condition grew steadily worse. Finally dulness, then stupor and death three weeks after operation.

In our opinion, this patient was fully entitled to operative intervention to put a stop to his bladder discomforts. Is not the wisdom of having decided on the two-stage procedure borne out by his inability to survive the simple first stage? Had a primary prostatectomy been performed his death would have been attributed to it and our bad judgment of the patient as a surgical risk.

The right position to take, as it seems to me, is well put in Kayser's conclusion, that "the two-stage method is not to be regarded as a 'normal procedure.'" As a rule, a relatively sound subject should be relieved of his troubles by the one-stage operation. It is not claimed that the two-stage method is free from danger. One of Kayser's cases died im-

mediately after the first stage; but many a victim of the one-stage method could doubtless have been saved by the two-stage procedure.

The two-stage operation is not necessarily a palliative procedure. It can be done from the viewpoint of a radical operation whenever we have to forego a one-stage method by reason of either bad general condition or renal insufficiency.

THE MECHANISM OF PROSTATIC RETENTION

By E. L. Keyes, Jr., M. D., of New York City

SEVERAL studies have recently been published on the mechanism of prostatic retention. Their conclusion is that prostatic hypertrophy may exist without retention, and that the true cause of retention is to be sought rather in the bladder muscle or innervation than at the bladder neck. They further support this theory with the many reported cases of what the French call "prostatism without a prostate," together with Albarran's theory of muscular weakness. A considerable operative experience, both with cases of frank prostatic hypertrophy, and with cases of prostatism without a prostate, has led me to quite an opposite conclusion, which I venture to offer for your discussion.

Two clinical types of prostatic retention may be distinguished: Chronic, incomplete or complete retention; and acute complete retention. Though they are related, it is better to discuss their mechanism separately, beginning with the former, the chronic type, since the elucidation of this makes the interpretation of acute retention a matter of but a few words.

Chronic Prostatic Retention

Prostatic retention represents the interaction of two forces: The bladder muscle, and the obstruction. The importance of each of these is best understood if they are discussed separately.

The Bladder Muscle

In discussing the action of the bladder muscle it is convenient to include the nervous mechanism that instigates the act of urination. We have, therefore, to note:—

1. The condition of the muscle itself.
2. The condition of the nervous system.
3. The condition of the will.

The Muscle Itself: Suprapubic cystotomy on an old prostatic often reveals a bladder muscle that grossly resembles blotting paper, and obviously possesses but little contractile force. Quite as often, however, one encounters a muscle with macroscopical and microscopical evidence of considerable vitality. After prostatectomy upon these patients the good or bad condition of the bladder muscle may have little effect upon the ultimate result. The patient with the "blotting paper" bladder is almost, if not quite, as likely to regain the power of emptying his bladder as the patient with the normal muscle. We can all recall many instances of complete cure after prostatectomy in spite of a "blotting paper" bladder, yet these are a little more liable to incomplete relief by prostatectomy than are their brethren with more normal muscle. But this difference is most marked in cases of small obstructions, contractures and, above all, in paralysis, as we shall note in a moment.

For, supposing for the moment that obstruction at the bladder neck *is* an element of prostatic retention, it is evident that just as a strong bladder may fight for a much longer time against an obstruction before it gives away; so, when the obstacle is removed, it must be more completely done away with to give entire relief to a sclerotic bladder than to a normal bladder.

Furthermore, the progressive weakening of the bladder muscle is doubtless the main agency in the rapidity or slowness with which the patient passes through the first and second to the third stage of prostatic retention. Though here again, the muscle is not the only element in the case.

The Nervous System: When the bladder muscle is paralyzed, as in tabes, the resulting retention is probably due in part to sphincteric spasm, for I have, by means of the Chetwood operation, satisfied myself that a diminution of the sphincteric obstacle at the bladder neck may result in considerable improvement of the patient's symptoms.

As a striking example of this let me cite the case of a

patient, thirty-four years of age, operated upon in October, 1907, at which time he had been suffering from difficulty in urination for eight years, and for six weeks had been urinating every two hours with incontinence both by day and by night. He showed a fairly constant residual urine of 75 c.c, denied syphilis, but had no patellar reflexes; his eyes reacted poorly, his prostate was normal, and he was sexually impotent. He had for a number of years suffered from lightning pains and paresthesiæ.

His convalescence after Chetwood operation was very stormy on account of fulgurating pains. The fistula did not close for two months. Ataxia, which was not present before operation, gradually came on during the ensuing year, and now, six years after the operation, he is markedly ataxic, and speaks of himself as a broken man. Nevertheless, his urinary organs have given him absolutely no further discomfort. He urinates painlessly four times by day, not at all by night.

A second tabetic, who had been ataxic for eight years, and used the catheter for seven, had from 100 c.c. to 500 c.c. residuum and occasionally had acute complete retention. Chetwood operation revealed and divided a dense contracture. His convalescence was complicated by severe lightning pains. After operation he had complete retention for two weeks and thereafter he learned that by holding his urine until the bladder contained at least 500 c.c. he could empty it down to 25 or 50 c.c. He continued in this condition until his death from pneumonia some two and a half years after operation.

A third case, of complete retention, so continued in spite of two Chetwood operations by me, and several punch operations upon the bladder neck. A similar failure resulted from the cauterization of the neck of a bladder paralyzed by trauma to the spine.

The diversity of these results is due to the fact that a paralyzed bladder goes into a state of retention when there is even the slightest obstacle to urination at the bladder neck. Indeed it is the paralyzed bladder that shows that curious

combination of incontinence and retention, not completely accounted for either by any considerable residual urine, or by a contracted bladder. In attempting the removal of this slight urethral obstacle to the emptying of the bladder, one is moved to great conservatism by the fear lest too bold an operation leave the patient more incontinent than before, and one is thus liable to remove only part of the obstruction in these cases where complete removal of the obstruction is most indicated.

The Will: The influence of the will upon the retention of urine in typhoid fever and other wasting diseases was very beautifully described by Dr. Samuel Alexander at the first session of the International Urological Congress. He ascribed retention in such cases to actual muscular weakness combined with weakness of the powers of attention. In some old prostatics I seem to have noted a similar unwillingness to take the trouble to empty the bladder. Quite recently an ancient Hebrew came into my service at Bellevue Hospital acutely overdistended, was relieved by suprapubic drainage and for the first twelve hours emptied through the drainage tube an average of about 600 c.c of urine an hour. A week later his prostate was removed under spinal anæsthesia and his suprapubic wound healed within three weeks thereafter. To my great surprise, as soon as the fistula had healed he proved to have retention of urine averaging about twenty ounces. The lowest amount we ever obtained from him was six ounces, the highest was forty-eight ounces. Yet, his general condition remained excellent for the two or three weeks he remained in the hospital, and his family, who had apparently turned him over to us with high hopes that they might get his savings bank account, rather despaired of my ability to kill him, and so refused permission for any further operation. It is my impression that had the old man been moved by a real desire to empty his bladder he probably could have done so. Doubtless you have seen similar cases, or at least you have seen that type of case in which after prostatectomy

the patient habitually retains from two to four ounces of urine, but if you inject into the bladder even a mild solution of permanganate of potassium, or silver nitrate, this is emptied out to the last drop.

In conclusion, therefore, it seems fair to state that the strength of the bladder muscle plays a large part in prostatic retention; and that when obstruction is slight and muscular weakness is the predominant cause of retention, removal of the obstacle at the bladder neck is a more delicate matter than when the bladder muscle has retained its strength.

The Enlarged Prostate

Let us repeat once more with Sir Henry Thompson and his followers, that not more than half the men whose prostates are enlarged suffer from prostatic retention, and let us add that some of those who suffer from prostatic retention have no hypertrophy of the prostate. These are the two facts which, as we said in the first place, impress those who deny that enlargement of the prostate has anything to do with retention of urine. If they will modify their claim and state that the size of the prostate has no bearing upon the *amount* of residual urine, we agree with them most heartily, but beyond this we cannot go. It is quite obvious that in most instances prostatic retention is due to hypertrophy of the prostate, and it is equally obvious that in most instances the removal by prostatectomy of the hypertrophied portions of the prostate relieves the retention. But in certain instances this is not the case. There are those who have no prostatic hypertrophy and to whom, therefore, prostatectomy is not applicable, there are those upon whom prostatectomy has been done without any influence upon their retention of urine, and on the other hand there are not a few upon whom a Bottini operation or a shockingly incomplete prostatectomy results in a cure.

These cases require explanation, and lead us to investigate more particularly the changes at the bladder neck as-

sociated with the various pathological conditions that excite prostatic retention. Before passing to these let us state, briefly and categorically, our views as to the role of prostatic hypertrophy in prostatic retention:

1. The mere fact of hypertrophy of the prostate is not of itself sufficient cause for prostatic retention.

2. In order to cause prostatic retention, prostatic hypertrophy must interfere with the outflow of urine from the bladder.

3. This interference may be due to deformity of the bladder neck (of which we shall speak in a moment) or to an actual compression of the urethra within the hypertrophied gland.

4. That this compression, or stricturing, of the urethra cannot usually be an important factor, is evident from several points of view: In the first place, the urethra is not strictured, but rather dilated, as a rule. In the second place, there is usually no obstruction whatever to the passage of a catheter through the prostatic urethra from the time it leaves the membranous urethra to the time it reaches the bladder neck. A canal that transmits an instrument so readily would scarcely offer any resistance to the passage of urine, however weak the bladder.

5. Hence, we are forced to the conclusion that even the lateral compression of greatly enlarged lateral prostatic lobes, probably has little or no effect in interfering with the outflow of urine.

We pass, therefore, to consider the nature of the obstacle at the bladder neck.

The Bladder Neck

In order to simplify the somewhat complex problem presented by the obstacle to urination at the bladder neck in a case of prostatic retention, let us at the outset recognize that such unusual conditions as hypertrophy of the anterior lobe, or enormous hypertrophy of the middle lobe, or other ec-

centric growths may produce a mechanical obstacle rather different in its nature from that which we usually encounter.

We, therefore, confine our observations to the usual types of obstruction which may be classified under the following heads:

1. Middle lobe hypertrophy, more or less pedunculated.
2. Lateral lobe hypertrophy, without recognizable middle lobe.
3. General hypertrophy, in which neither lateral nor middle lobe are prominent.
4. General hypertrophy, in which middle or lateral lobe, or both, are prominent.
5. Contracted bladder neck.

It would obviously be quite impracticable, and happily it seems quite unnecessary, to consider the mechanical obstacle to urination caused by these different pathological conditions *seriatim*. The obstacle is much the same whatever the cause. In order to appreciate its nature let us first compare the observations made by the examining finger when introduced through the perinæum into the prostatic urethra of the normal case and the case in prostatic retention. Let us suppose in the first place a patient with stricture of the urethra that has been divided by perineal section. The finger is introduced into this wound, passes through the membranous urethra, usually tearing this somewhat; thence into the prostatic urethra, which is identified as a somewhat dilated portion of the canal that readily admits the tip of the finger; and thence into the normal bladder neck, recognizable as an elastic muscular ring, beyond which the tip of the finger may be pushed into the emptiness of the bladder cavity.

Palpation of this muscular ring reveals that it is not prominent upon the roof of the urethra, while it grows more prominent as it approaches the floor. Thus the finger lying in the urethra with its tip against the bladder neck pushes against that part of the ring which even in the normal state rises up to make a slight muscular bar between the floor of

the urethra and the floor of the bladder. In prostatic retention this obstruction to the entrance of the finger into the bladder is much more marked. As the finger passes through the prostatic urethra it may encounter and note the presence of prostatic lobes projecting into the canal laterally, or from below, and at the bladder neck, but it also recognizes that the chief obstacle is at the neck of the bladder whether this obstacle be due to prostatic hypertrophy in the form of a middle lobe, or bar, or to contracture. Indeed, it recognizes that when the bladder neck is tightly contracted, this contraction occurs almost entirely at the expense of the floor, while if only the lateral lobes of the prostate are enlarged the obstacle to the entrance of the finger into the bladder is a veil or bar of bladder neck lifted up between these lateral lobes.

The same observation may be made if these various pathological conditions are examined from a suprapubic opening into the bladder. Whether there be a general "horse collar" hypertrophy, a contracture, a lateral hypertrophy, or a middle lobe, the finger introduced into the posterior urethra recognizes that between it and the bladder, on the floor of the urethra, there is elevated an abnormal obstruction. This obstruction is the mechanical cause of prostatic retention. It arises from the floor and lateral walls, not from the roof, even in cases of contracture and of lateral prostatic hypertrophy, because the roof of the urethra is more fixed (by the pubo prostatic ligaments) than is the floor.

The precise way in which this obstacle interferes with the outflow of urine from the bladder has never been absolutely proven. Unquestionably it prevents the normal opening of the internal sphincter, thus checking the urinary stream. But, why does it in so many cases reduce the bladder to a condition of partial retention in which the amount of residual urine is practically constant whether the patient stands upon his head or upon his feet? The explanation of the phenomenon is suggested by the fact that if a bubble of air is injected into the normal bladder this always issues after

the last drops of urine are passed. In other words the bubble floating on top of the urine under the vault of the bladder, is the last thing to issue in a normal urinary act. Moreover, if the bladder contains thick, tenacious pus delivered from a pyonephrosis, and lying upon its base, this pus will issue at the end of the urinary stream, and immediately ahead of the bubble of air. If there is retention of urine neither the pus at the bottom of the bladder nor the air at its vault are extruded.

To explain these phenomena we must assume that as the bladder empties itself the trigone is somewhat elevated forming the flare of the funnel which in a normal bladder begins in the prostatic urethra and the remainder of the bladder closes down upon this funnel, the lowest and highest points in the bladder cavity lying posterior to the trigone and being emptied last. But when there is retention the funnel is an inadequate one, the bladder neck fails to open as it should, and the result of the effort to squeeze out the last drops of urine is to close the bladder neck. The closure should be interpreted not as a sphincteric gripping, but as the driving of the prominent lower lip of the bladder neck against the upper part of the neck and the adjacent portions of the prostatic urethra. If the closure were sphincteric a hard push might force it and drive out a few drops more of urine, but inasmuch as it is rather the application in the form of a valve of the prominent lower portion of the sphincter against its upper portion, the harder the patient strains the tighter does the valve close. The only way he can pass any more urine is by relaxing his muscles and permitting the sphincter to open a little. Then another effort may bring forth quite a flow of urine before the valve flaps shut again.

Acute Complete Retention

Chronic retention is due fundamentally to an inability of the bladder sphincter to open until the bladder is partially full. Acute complete retention is due to a congestion

and spasm at the bladder neck of such intensity as to apply the posterior lip of the sphincter against the anterior even when the bladder is full. Operation upon such a case does not reveal an impassable closure of the neck of the bladder, as would be the case were the obstacle a sphincteric or stricture-like one, and not a valve-like one.

The mechanism of acute complete retention is, of course, the same in prostatic abscess as in prostatic hypertrophy.

One readily understands without further comment how various combinations of obstruction, congestion and spasm produce the many variations in the clinical phenomena of prostatic retention, while the gradual progress of the increase in the amount of retention of the urine as the months go by is due largely to gradual decrease in the strength of the bladder muscle.

Practical Deductions

Several practical conclusions may be drawn from the above remarks. In the first place, since mere prostatic hypertrophy is not enough to cause prostatic retention, prostatic retention may sometimes be relieved by removal of the obstacle at the bladder neck without any attention to the prostate, even when this is hypertrophied. This the Bottini operation used to do blindly, and as it were accidentally, while the Chetwood operation achieves it intentionally. I have several times relieved the retention, great or small, of a patient whose prostate showed bilateral enlargement, simply by dividing with the Chetwood instrument the bar at the neck of the bladder, while paying no attention to the enlarged lateral lobes. The same thing can sometimes be done when the median lobe of the prostate is hypertrophied in the form of a bar or a pedunculated lobe, though it is obviously safer under these circumstances to remove the bar or lobe. But the point illustrated by the success of the Chetwood operation is that an attack directed solely upon the bladder neck at its lowermost part can relieve prostatic retention. Yet, when the pros-

tate is considerably enlarged it were obviously futile to satisfy one's self with division or excision of the bar or middle lobe. For then the lateral masses at the bladder neck crowd in and still interfere materially with the opening of this orifice. Indeed whatever the condition of the bladder muscle at the time of operation we can count upon this growing weaker as the years elapse. Hence our ambition should be to remove all possible obstacles to urination, including all hypertrophied portions of the gland.

But, it cannot be too often repeated, the prostatectomy,—the removal of the hypertrophied portions of the prostate gland—must be looked upon only as a means to an end, that end being the removal of the obstacle at the bladder neck. Hence the technical disadvantage of perineal prostatectomy, especially for the neophyte who is likely to be satisfied with removal of the more immediately presenting portions of the hypertrophied prostate, while totally disregarding the obstructing bladder neck that lies beyond. Hence, also, the mechanical superiority of suprapubic prostatectomy, since the attack from above inevitably at least tears open the neck of the bladder, while this is the last region reached from below.

It has been our experience that no operation for prostatic hypertrophy will give one hundred per cent. of cures among the survivors, for the peculiarities of healing after operation and the weakness of the bladder muscle may well frustrate our most intelligent efforts. Yet, in conclusion we should like to insist in theory as we always have in practice that the problem of prostatic retention is a mechanical problem; that the bladder neck, and especially the elevation of its inferior lip, is the important mechanical obstruction, and that prostatectomy, suprapubic or perineal, total, sub-total, or partial, should be performed for the purpose of obliterating this obstacle at the bladder neck.

SUPRAPUBIC PROSTATECTOMY

By Hugh Cabot, M. D., of Boston, Mass.

I AM led to present this paper at this time less because I have new material to present than because I believe it to be the duty of each one of us who is engaged especially in this work to express from time to time his opinions upon important questions under discussion and to give his reasons for the faith that is in it. Even if no absolutely new facts are presented, information of value may be forthcoming because the facts are seen from a somewhat different angle. Furthermore, I feel that no apology is due to this Association for the discussion of the subject of prostatectomy as, to this society in times gone by, have been brought the contributions of Belfield, Bryson, Watson, Alexander and Young.

For the sake of clearness and because I feel that the problems are of a somewhat different nature I shall confine myself to the discussion of the management of those types of enlargement of the prostate commonly referred to as hypertrophy. I desire at this time to pay my respects to the phrase of hypertrophy of the prostate as at once inaccurate and misleading. The process referred to by this name is not true hypertrophy. In the first place, as has been pointed out by many, including Geraghty, it is not a process correlated to other processes ordinarily referred to as hypertrophy for it occurs at a time of life when atrophy and not hypertrophy is taking place. Again, this so-called hypertrophy involves only certain portions of the gland and if the term is to be used at all it should be clearly stated in what parts of the gland the abnormal tissue originates. Work modern and less modern seems to me to have made it abundantly clear that the process is not hypertrophy but the formation of new tissue of adenomatous character arising in certain portions of the gland and replacing in whole, or in part, the

normal tissue. This distinction is important and not a mere quibble, for upon a more or less thorough understanding of the position and origin of these adenomata must depend our belief as to the most successful and efficient methods of attacking them. If we were to proceed upon the theory that this is a true hypertrophy involving all portions of the gland we might readily reach the extraordinary position occupied by Mr. Freyer and Mr. Thompson Walker, viz., that by what he is pleased to call his (Freyer's) method the whole gland is removed,—a question to which I shall have occasion to refer later. I hope that the weight of opinion of this Association will be thrown in the direction of removing this troublesome misnomer from the field of medicine.

Origin of the Adenomatous Masses

Appreciating the fact that the process is due to new formed tissue in the form of adenomatous masses it then becomes essential to clearly comprehend from whence these masses arise and also to bear in mind the anatomical division of the gland into lobes which are constant. The excellent study of Lowsley has crystallized our knowledge upon this subject so that we are in a position to declare that the division of the prostate into a posterior, a median and two lateral lobes is correct, bearing in mind the occasional persistence of an anterior lobe which ordinarily disappears in fetal life, and the more or less frequent occurrence of detached groups of glands such as the sub-cervical group described by Albarran. The disagreement of Tandler and Zuckerkandl with this classification is, I think, more apparent than real for it seems to me to depend simply upon a definition of the extent of the median lobe which they regard as including what Lowsley has shown to be the lateral lobes. The distinction does not seem to me important. Recent work makes it abundantly clear that the adenomatous masses, ordinarily referred to as hypertrophy, arise from the median lobe, the lateral lobes and occasionally from the

sub-cervical glands and a persistent anterior lobe. There is no evidence that they ever arise from the posterior lobe and this should be appreciated if we are to get any clear understanding of the tissues to be traversed in attacking the masses and the amount of tissue actually removed in any given operation.

Anatomical Considerations

Though I regret to have to take this Association over ground which is largely or wholly familiar I feel required to point out the different nature of the covering of these adenomatous masses when they arise from different portions of the gland. Thus, the masses occupying the lateral lobes are covered posteriorly by the posterior lobe and do not here come in contact with the capsule of the prostate. Laterally they lie against the true capsule of the prostate or, as Mr. Thompson Walker calls it, the sheath. Superiorly they abut upon the median lobe and in the absence of development of this lobe upon the muscular structures of the bladder neck. Mesially they are covered only by mucous membrane and by the stretched and atrophied capsule of the prostate *from which they cannot be separated by dissection even after removal from the body.*

The mass arising from the median lobe is covered posteriorly by the posterior lobe and as its overgrowth takes it backward it comes to a greater or less extent in contact with the muscular structures of the bladder neck and the bladder wall itself. Laterally it abuts upon the lateral lobes. Anteriorly and superiorly it is, like the lateral lobes, covered only by the thin atrophied mucous membrane from which it is inseparable.

Relation of the Posterior Lobe to the Urethra

It will be remembered that the posterior lobe is by definition that portion of the prostate which forms its posterior surface and lies wholly behind the ejaculatory ducts. It thus forms the floor of the urethra from the apex of the prostate

to the verumontanum and from this point ceases to touch the urethra and runs backward in a narrowing triangle behind the median lobe. The sides of the urethra are throughout formed by the lateral lobes and the floor of the urethra from the veru to the bladder orifice is formed by the median lobe. This accounts for the horse-shoe form of many adenomatous prostates removed from above, in which the sides of the horse-shoe are formed by the lateral lobes while the bow is formed by the median lobe. It further accounts for the well recognized fact that in enucleating the prostate by the intra-urethral method, whether from above or from below, the mucous membrane tears on the sides at the junction of the floor and the lateral wall up to the verumontanum at which point it tears transversely following the line of the median lobe. Upon this depends the undoubted fact that by this method of enucleation the posterior lobe and its structures, particularly the ejaculatory ducts, are left undisturbed.

What Portions of the Prostate are Removed by the Method of Enucleation Whether from Above or from Below?

It seems to me important to take up this question inasmuch as our English brethren, particularly Mr. Freyer and Mr. Thompson Walker still apparently cling to the idea that the whole prostate is removed. This was specifically stated by the latter at the meeting of L'Association Internationale D'Urologie in London in 1911. A careful investigation of the material upon which he bases this claim singularly fails to establish the fact. It will I think be generally admitted that the removal of the whole prostate must involve the removal of the posterior lobe. If the posterior lobe is removed clearly with it must be removed those portions of the ejaculatory ducts which lie between the verumontanum and the capsule. These structures are strikingly absent not only in the specimens described by Mr. Thompson Walker but in all the specimens to which I have had access, a not inconsiderable number. The specimens herewith presented show in section that

these ducts lie wholly behind the adenomatous masses of the lateral lobes and the median lobe. As the posterior lobe is never involved in the process, the line of cleavage necessarily passes in front of it and it is from this, the posterior lobe, that the process described by Mr. Freyer as the "shaking free" of the masses takes place. It is probably not necessary to pursue the discussion of this point further since the absence of ejaculatory ducts structures from the specimens is sufficiently conclusive proof. What actually occurs in these operations of enucleation is that the adenomatous masses in the lateral and median lobes are shelled out from the capsule of the prostate on the side, from the muscular structure of the bladder neck above and from *the posterior lobe, the old so-called surgical capsule, below.*

A Comparison of the Tissues Involved in Prostatectomy by the Suprapubic Route and by the Perineal Approach of Young

Dr. Young has described his operation as conservative prostatectomy and it is therefore proper to inquire in what respects it is conservative as compared with other methods. I believe that this term "conservative" was intended to apply chiefly to the conservation of the ejaculatory ducts and to the avoidance of injury to the structures involved in the nervous mechanisms pertaining to potency. In the suprapubic method of approach the masses are reached by breaking through the mucous membrane in the urethra and enucleating the masses from the posterior lobe and that portion of the urethra lying in front of the verumontanum which is left intact. The median portion is separated from the grasp of the muscles of the bladder neck which lie in a relation to it, varying with the amount and direction of the growth. The posterior lobe structures are not disturbed and frequently not even uncovered. In Young's operation these masses are approached from behind through oblique incisions intended to avoid injury to the ejaculatory ducts. The incisions traverse

PLATE XXXII.—Presented by DR. HUGH CABOT

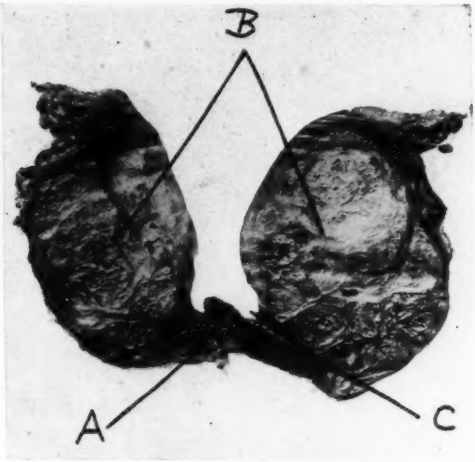

Fig. 1

Sagittal section of adenomatous prostate about level of verumontanum. A, posterior lobe; B, adenomatous masses in lateral lobes; C, line of cleavage at junction of lateral wall and floor of urethra.

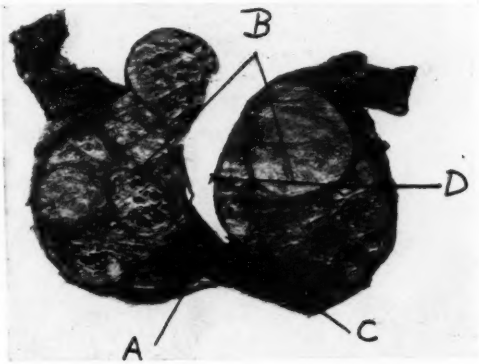

Fig. 2

Section of same prostate as Fig. 1, about 1 cm. further back. A, posterior lobe; B, adenomatous masses in lateral lobes; C, line of cleavage at junction of lateral wall and floor of urethra; D, mucous membrane from under which lateral mass B must be enucleated in Young's operation, Note the probability of leaving adenomatous tissue along the urethra when attempting to enucleate mass B from below by Young's method.

PLATE XXXIII.—Presented by DR. HUGH CABOT

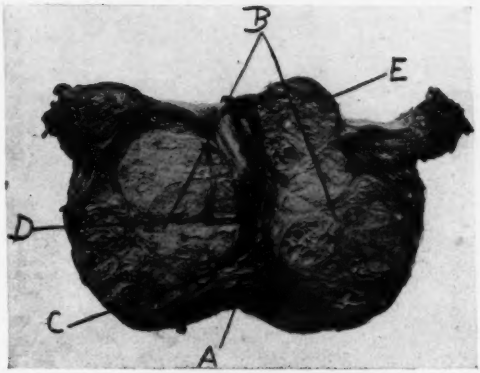

Fig. 1

Section of same prostate as Fig. 1, of PLATE XXXII, about 1 cm. further back than Fig. 2. Note the extreme thinness of the covering of the adenomatous mass B at point D. The chance of removing mass B and leaving behind the portion E is obviously great if approached from below by Young's method.

the whole thickness of the posterior lobe which has been referred to under the misleading term of the surgical capsule and this is of necessity a destructive procedure. Furthermore, the position of the ejaculatory ducts is not as constant as has been often believed for their position is influenced by the irregularities of growth of the lateral masses and they may lie close together on the posterior surface of the gland or be considerably separated, especially as they approach the upper border of the gland. For most of us the avoidance of the ejaculatory ducts is at least highly speculative and I have yet to see any operator other than the father of this operation executing the procedure in a way which seemed to me at all likely to lead to anything properly regarded as a conservative result. In my hands it could only be described as highly destructive. But the most difficult part of the operation executing the procedure in a way which seemed to me enucleated from inside of their capsule but it must be remembered that these lobes are covered by nothing properly described as a capsule but only by mucous membrane and a little fibrous tissue which adheres to the lobes with extreme intimacy. If these lobes are to be truly enucleated they must be enucleated from under the mucous membrane. This I do not believe to be an anatomical possibility as I have tried to remove this mucous membrane many times after the lobes had been taken out from above and have found it impossible even sitting quietly at the dissecting table. I present herewith specimens and illustrations which seem to me to show the absolute fallacy of the conception. What does take place, as a matter of fact, in the hands of those who attempt the operation of Young is the enucleation of greater or smaller portions of these lateral and median masses from within the masses themselves, the amount of adenoma left behind depending upon the lines of cleavage within the mass and the experience and dexterity of the operator. The adenomatous tissue left behind vitiates the result of the operation in two ways. In the first place according to its amount and position

it reproduces more or less exactly the form of the obstructing tumor present before operation which may flatten down considerably as the hollowed out cavities within it contract. It thus remains largely a matter of accident as to whether the relief to the patient is large or small. In the second place a hardly less serious objection is that from the adenomatous tissue left behind new masses are formed and the patient has no assurance that his obstruction is permanently at an end. I do not wish to convey the idea that prostatectomy as done by Dr. Young is not of benefit to his patients but the operation as described by him I believe to be faulty in conception and inefficient in execution in the hands of all but its distinguished author.

Since the term conservative has been applied to this method of perineal prostatectomy it seems to me that we are entitled to inquire of what the conservation consists. I have always assumed that the term was intended to apply to the conservation of the ejaculatory ducts, the remaining prostatic tissue, therefore the posterior lobe (miscalled surgical capsule) and the nerve fibers traversing the prostate and ending in the neighborhood of the verumontanum. If I have correctly understood the author it must now be abundantly clear that no such result can be expected from this operation. The attack traverses directly the only important part of the remaining prostatic tissue. The avoidance of the ejaculatory ducts is, to put it mildly, extremely problematical and it is far more sound to describe it as destructive than as conservative of these tissues. The operation by intraurethral enucleation to a large extent avoids this damage and particularly when carried out from above may leave them almost wholly intact. I desire however to repeat what I have elsewhere said, that I think altogether too much stress has been laid upon the conservation of these structures. The end and object of the operation of prostatectomy is to remove the obstruction and no minor issues should blind us to the supreme importance of its absolute accomplishment. Since however stress has been

laid upon this point it seems to me proper to point out that in this regard it cannot be accepted as accomplishing the end.

If I have made myself clear in what I have said above it necessarily follows that for anatomical reasons which cannot be controverted, prostatectomy must be done by some form of intra-urethral enucleation and it remains only to discuss whether the results are most satisfactory when this is undertaken from above or from below. Having regard only for the functional results I believe that the suprapubic route is far superior. By this method it can be declared with certainty that if the patient survives the operation the function of the bladder will be restored practically to normal. By the perineal method of attack certain more or less objectionable sequelæ not infrequently occur. The approach is such that the muscular control is jeopardized, particularly in the case of large masses and a certain number of cases of incontinence more or less partial is almost certain to result. Fistulæ of various kinds always have, and I believe always will, occasionally result, those communicating with the bowel being the least common but most serious.

For these reasons it seems to me that in dealing with the type of prostate in which the obstruction results from the formation of adenomatous masses the suprapubic route has a clear advantage over the other methods of attack.

SUPRAPUBIC PROSTATECTOMY
FACTORS INFLUENCING THE MORTALITY OF

By Hugh Cabot, M. D., of Boston

MUCH as I should like to hold a contrary view I still believe that the operation of suprapubic prostatectomy has a higher mortality as at present performed than when the operation is done by the perineal route. The high operation is I believe far more efficient and that for this reason we might be willing to accept a higher risk but not until it appears that we have reduced the mortality to the lowest possible figure compatible with efficient work. There are three factors which contribute most importantly to the mortality of operation and to these I would direct your attention. These are the anæsthetic, the shock, entirely apart from bleeding, and the bleeding itself.

Choice of Anæsthetics

For practical purposes in this country the choice of anæsthetics is limited to three at the present time. Ether, gas and oxygen and spinal anæsthesia. Perhaps because I come from the birthplace of ether I have learned to dread it as an anæsthetic for people past middle life. We have been in the habit of falling back upon the very flattering statistics of ether anæsthesia because we have been far too prone to deal only with immediate mortality. It is no new conception to you that the danger from ether is largely in its tendency to irritate the mucous membrane of the lung. Patients requiring prostatectomy are peculiarly liable to have lung conditions likely to resent irritation, particularly chronic bronchitis, emphysema or even moderate œdema of the bases. If we add in as part of the mortality of the anæsthetic the cases which ultimately die from acute bronchitis, bronchial pneumonia or even frank pneumonia after prostatectomy I believe that we shall inevi-

tably come to regard ether not as the safest but probably the most dangerous of general anæsthetics.

Gas and Oxygen

Of late years the advance in our ability to manage gas and oxygen has increased enormously and it is now among the most valuable at our disposal. It has, however, certain perfectly distinct disadvantages when applied to this class of cases. It is not a safe anæsthetic for patients with diseased hearts and these are admittedly common in this class of patient. Moreover, the mere mechanical difficulties of administration to these lantern-jawed, full bearded people is by no means inconsiderable and these objections to my mind go far to vitiate its value as the anæsthetic of election.

Spinal Anæsthesia

There can be no question that this method of anæsthesia is the ideal one if we come to believe that it is as safe or safer than those with which it must be compared. It obviously removes the dangers attendant upon general anæsthesia in patients with damaged hearts or lungs and we have no reason for believing that it exerts an unfavorable influence upon the action of the kidney. We come down therefore directly to the question of the risk. I believe that statistics are now at hand from reliable sources extending over a term of years to show that this method of anæsthesia carries no considerable danger. I have been unable to find evidence that the mortality is more than one in a thousand, but even if we were to admit a mortality of one in five hundred it would still have a long lead over any form of general anæsthesia. Looked at purely from its anæsthetic qualities, I believe it to be no more dangerous than the other anæsthetics and for reasons which will shortly appear I think it to have commanding advantages.

Shock

In any discussion of shock we should I think sharply distinguish the shock which arises from trauma and that which

appears in connection with loss of blood. At this point I desire to confine the word shock to that which has no relation to bleeding. It seems to me clear that the shock of the suprapubic prostatectomy is considerably greater than that of the perineal operation, done with equal skill. This must be due to damage to nerve endings to the tissues traversed by the operation and therefore chiefly to the tissues of the abdominal wall and of the bladder wall itself. It is not clear to me why the manipulation of the prostate, whether from above or below, should be essentially different in this regard, though there is some evidence to show that such is the case. The work of Crile in the elimination of shock and the late results of shock, is doubtless familiar to all, and his method of operating under what he has called anoci-association has been widely discussed. The soundness of his general conclusion seems to me so clear as to be convincing and I have for a considerable time adopted his technic in all abdominal operations but this technic does not seem to me thoroughly applicable to operations upon the prostate. I have not been able by his method to obtain efficient "block" of the structures in the neighborhood of the prostate and it has not seemed to me that the anæsthesia of the bladder wall was complete. The only absolutely satisfactory method of completely blocking nerve stimulæ from this region is spinal anæsthesia and since I have employed this as a routine measure for all operations upon the prostate the elimination of shock has seemed to me absolute. These patients go through operation without change in character of the pulse and I have been unable to see that the operation had any effect upon their nervous mechanism.

If the observation of others bears out this view it will go far to clinch the supremacy of spinal anæsthesia for these operations.

Bleeding

It has of course been generally recognized that the control of bleeding was an important factor in the success of

operation and yet I do not think that recognition has been as complete as the situation requires. We have been too likely to be satisfied with control of bleeding to such an extent that it did not obviously cause the death of the patient and have not been sufficiently alive to the fact that loss of blood is a factor in mortality through its ability to lower general resistance. The ability of these patients to successfully withstand operation rests upon a very delicately balanced mechanism and any extra load thrown upon them from any source may tip the scale. Infection in one form or another is an important factor in mortality and this at the last analysis depends far more upon lowered resistance than upon the actual contact of bacteria with raw surfaces. We have taken considerable trouble to avoid the more gross forms of wound infection and have planned our operations with this in view, overlooking the fact that the resistance of the patient is a far more important factor. More and more I have been impressed with the fact that if we avoid disturbing the balance of the protective mechanisms which guard the patient against infection through faulty management of anæsthetics, prolonged traumatic operations and loss of blood it matters little by what precise technic we achieve the result. These patients may be compared, in regard to their ability to lose blood, to children in whom we recognize the fact that operation must be done "as dry" as possible. I wish therefore to discuss in detail the methods of controlling bleeding because they do not seem to me to have been as efficient as the situation requires.

Usual Methods of Controlling Bleeding

A very considerable number of operators by the suprapubic route cannot properly be said to take any method of controlling the bleeding and are content with the uncertain contractility of the structures from which the masses have been removed and the formation of thrombi in the veins. This method, or lack of method, seems to me altogether too hap-

hazard and if we believe that loss of blood should be reduced to a minimum we cannot assent to this method of trusting to the unknown abilities of the individual patient. Next in order of frequency probably comes the use of irrigations either hot or cold, either constant or intermittent. This method appears to me no great improvement over nothing, for while it undoubtedly has a tendency to check bleeding partly by the actual temperature of the irrigating fluid and partly by keeping the bladder free from clots, which will cause dangerous distention, it is altogether too inaccurate to stand the demands of a scientific surgical procedure. Although with its use most patients will recover some patients will be lost through actual loss of blood or the more elusive results of bleeding commonly put down in the records as sepsis, pneumonia or other form of infection.

Packing

A more accurate and certain method of control is to be found in the use of gauze packing in various forms. A considerable variety of methods have been employed, all more or less efficient. The older and more crude method of packing gauze directly into the cavity and bringing it out through the wound without providing other drainage of the bladder is open to the great objection that it leaves the patient constantly wet and exposes the freshly traumatized tissues to the contact of more or less infected urine. It is an unnecessarily crude method. The better method is that employed by Mitchell, Davis and others of using a long, narrow strip of gauze which is then brought out through a good sized suprapubic tube, either metal (Davis) or rubber around which the bladder wall can be closed snugly and the wound kept dry. In due time the gauze is removed through this tube without disturbing the drainage of the bladder. This is to my mind the most efficient method of packing and would be that of election except for the fact that packing seems to me objectionable no matter how well done. Packing necessarily means

tissue necrosis. Tissue necrosis invites infection and infection is on the whole the largest factor in mortality. If the bleeding can be controlled in no other way then packing must be the choice, but I am firmly of the opinion that it can be efficiently controlled by far better means and upon a more accurate knowledge of the sources of this bleeding will depend our ability to control it.

Sources of Bleeding

It has I think been generally assumed that the important bleeding came from the veins lying in the sheath of the prostate, the so-called peri-prostatic plexus. It has been too little recognized that the most important bleeding was arterial and not venous, important because more difficult to manage. With a larger incision in the bladder wall, which it has been my habit to employ during the last year, ample opportunity has been given of seeing exactly where the blood comes from and I have been surprised to note that it came largely from the upper portion of the wound where the masses were separated from the muscular structures of the bladder neck. There are often good sized spurters coming from just beneath the torn mucous membrane at the bladder neck and the amount of actual bleeding from the cavity has been comparatively small. With these facts in view I have come to believe that in some method of suture will be found the most efficient control of bleeding and I have employed a considerable variety with a more or less measure of success.

Methods of Applying Sutures to the Neck of the Bladder

In order that this may be done with any efficiency a much freer incision in the bladder wall is necessary than has been customary in the past. In other words a thoroughly good exposure of the field must be had. It will be objected that this unnecessarily prolongs the time and increases the trauma of the operation. To this it may be answered that under spinal anæsthesia time is comparatively cheap as the patient is sub-

ject to no strain and the difference of ten or fifteen minutes in the length of an operation is I believe negligible. Moreover the shortness of many of the operations in which enucleation is done through a small suprapubic incision is more apparent than real because when the patient is returned to bed the operation is not in any proper sense finished. Bleeding is still going on, often of a considerable amount, which is depriving the patient of that which he needs, his blood, to a far greater extent than would a moderate continuance of the operation resulting in a dry wound. Our ideal in these cases should be to get the bladder so dry that we could close it without drainage, though I believe such a closure to be in the highest degree unwise. A good exposure of the bladder must be obtained. The masses are then removed by enucleation and with retractors in the bladder and the foot of the table more or less elevated the source of bleeding is sought for. As I have already pointed out, this comes in considerable part from the bladder neck and to this region sutures should be applied. I have not been able to make any efficient application of sutures to the walls of the cavity with a view to its obliteration and incline to regard this as anatomically impossible owing to the fixed relation of the lateral wall to the pubic arch. I have, however, gotten efficient control of bleeding by whipping with a catgut suture what may be termed the neck of the bladder. This may be done by carrying a small, rather full, curved needle down into the cavity from which the prostate has been removed and bringing it out through the lateral wall close to the pubic bone on one side or the other including all the muscular structures of this region. In this way a considerable bite of tissue is obtained. The suture is then carried toward the floor of the bladder as a continuous suture and is stopped just short of the middle line. The same procedure is carried out on the opposite side, thus to a greater or less extent puckering up the bladder neck. In some cases where there is considerable laxity of the tissue this puckering will result in more or less diaphragm formation. When this occurs the dia-

phragm should be cut through on the floor either with scissors or the cautery and any bleeding resulting from this maneuver controlled either with suture or cautery. The result of this suture is to considerably narrow the bladder neck at the same time giving free drainage on the floor at the lowest point. What is far more important as a result is that the bleeding is efficiently controlled and no packing is required. Further experience is necessary to simplify the method and it may well appear that some other plan of applying sutures will be better. I am not wedded to this or any other particular method but am much impressed with efficiency of suture in some form and regard it as the most certain method of controlling what I am convinced is the most important factor in mortality. The operation is finished by the closure of the bladder wall by suture around a medium sized drainage tube and it has been our custom to leave an inlying catheter in the urethra through which the bladder could be irrigated both for the purpose of accurate knowledge of the amount of bleeding and to prevent absorption in cases where the bladder is seriously infected.

In closing I want to urge strongly the importance of paying attention to the three important factors at present influencing the mortality of suprapubic prostatectomy. The anæsthetic, the production of shock by traumatic operating and the inefficient control of bleeding. When these factors are reduced to a minimum as sources of danger suprapubic prostatectomy will be the method of election for all cases of adenomatous enlargement of the prostate and the perineal operation will have passed quietly into history.

VITAL STATISTICS OF PROSTATECTOMY

By J. Bentley Squier, M. D., of New York City

IN a paper read before the Medical Society of the State of New York, in January, 1909, the writer detailed the fatalities occurring in a series of one hundred operations for removal of the prostate gland.

Of these hundred cases, seventy-one were operated by the perineal route and twenty-nine by suprapubic.

Death as a probable result of operation took place in seven instances. Four following suprapubic and three perineal operations. (See New York State Medical Journal, April, 1909.)

The statement was made in this paper that "if reliable data could be collected the percentage of deaths directly due to catheter life would probably exceed that of prostatectomy at the hands of competent operators." Even though this statement is accepted as a fact by most surgeons, the medical profession at large have still to be convinced of its truth.

In order to add testimony to the aforementioned statement, I have included in this study the vital statistics of a series of patients suffering from varying degrees of prostatic obstruction who were not subjected to operation as well as those of the operative cases.

The cases selected for study are only those who have been under my care during the past four years and whose histories I have been able to follow up to the time of death or to the present.

These cases for the sake of comparison have been arranged into two groups: First, those who for various reasons have refused operative relief and second, those operated upon.

TABLE I.

At Time of Examination			Catheter Life	Residual Urine	From Time of Examination	
Name	Age	Duration of Symptoms			Living	Dead
V–M	69	6 months (Primary)	No	8 oz.	Living, 1 year	
D–Y	71	10 years	No	4 oz.	Died, 1 year, Nephritis	
H–T	72	3 years	Yes, 1 year	All	Abscess of prostate, Sepsis, Died	
C–Y	65	4 years (Primary)	No	2 oz.	Died, 18 months, Nephritis	
M–R	65	1 year (Carcinoma)	Yes	All	Died, 14 months from onset	
M–C	49	3 years (Fibrous)	No	4 oz.	Died, 4 months from Endarteritis	
D–S	65	3 years (Ac. Retention)	During attacks	6 oz.	Died 12 months, from Uræmia	
G–N	74	5 years (Ac. Retention)	1 year	All	Died 1 year, from Uræmia	
H–T	58	2 (Primary Symptoms)	No	4 oz.	Living, 2 years, no secondary symptoms	
L–N	50	3 months (Carcinoma)	No	.....	Died in 3 months	
K–G	40	6 months (Carcinoma)	No	.....	Died in 6 months	
M–E	35	1 year (Carcinoma)	No	.....	Died in 2 months	
E–R	59	2 years	No	3 oz.	Living, 4 years	
K–M	60	1 year	Yes	8 oz.	Died, 18 months, Uræmia	
B–S	66	2 years (Primary)	No	2 oz.	Living and well, 3 years	
H–S	63	6 months (Primary)	No	3 oz.	Living and well, 4 years	
S–N	67	3 years	Yes, 2 years	8 oz.	Died, 1 year, Sup. Nephritis	
C–E	80	1 year	Yes, 1 year	All	Died, 3 months, Sup. Nephritis	
F–G	71	1 year (Carcinoma)	No	.....	Died, 6 months, Sup. Nephritis	
C–N	63	3 years (Primary)	Yes, in attacks of retention	.....	Died, following infection from catheter, 2 years	
R–L	62	6 months	No	6 oz.	Died, 2 years, Nephritis	
R–S	72	6 mos. (Ac. Retention)	No	2 oz.	Died, 3 years, Endarteritis	
M–R	70	15 years	Yes, 15 years	All	Died of Pneumonia	
M–K	67	3 years	Yes, 1 year	8 oz.	Died, 2 years, Apoplexy	
H–S	52	Ac. Retention	Yes, 2 years off and on	.....	Died, 2 years, Sup. Nephritis	
B–E	69	2 years	No	6 oz.	Living with secondary symptoms	
B–E	59	2 years	No	4 oz.	Died, Uræmia	
Lee	60	5 years	Yes, 5 years	8 oz.	Living and well	
K–N	59	18 months	Yes, 6 months	20 oz.	Died, 6 months, Uræmia	
L–G	65	4 years	Yes, 6 months	4 oz.	Died, 1 year, Nephritis	
S–K	63	1 year	Yes, 12 months	8 oz.	Living with secondary symptoms	
S–R	64	6 years	Yes, 18 months	7 oz.	Died, 2 years, Uræmia	
A–T	61	3 years	Yes, 12 months	8 oz.	Died, 1 year	
W–N	73	4 years	Yes, 12 months	20 oz.	Living with secondary symptoms	
S–V	68	4 years	No	3 oz.	Living and well, 2 years	

Group I. Cases of Prostatic Obstruction not Subjected to Operation

This group consists of thirty-five patients presenting primary or primary and secondary symptoms of prostatic obstruction of sufficient severity to warrant operation. The division of the symptoms into primary and secondary is an arbitrary one, considering those symptoms produced by the mechanical obstruction, namely, increased frequency of urination, burning, urgency and tenesmus as primary and anorexia, anuria, loss of weight and strength, etc., as secondary.

Five cases of carcinoma are included to record the frequency of its occurrence in relation to benign hypertrophy.

Table I gives in brief the salient features.

Summary of Group I.—Thirty patients suffered from benign hypertrophies and five from malignant disease. Seventeen were upon catheter life, using the catheter only during the attacks of acute retention, once or twice a day to relieve over-distension, or were completely dependent upon the catheter. Of these seventeen, fourteen have died, with an average duration of life of two years and ten months after commencing catheter life.

Included in the list is the one exception, namely, a patient who had lived fifteen years after beginning the use of the catheter and died of an intercurrent disease: Pneumonia.

The cause of death in twelve cases was directly responsible to suppurative renal lesion, nephritis plus sepsis. One died of apoplexy.

Three are living, two at the end of one year and one at the end of five years.

Of the patients not upon catheter life, the mortality during the same period of observation as with the others, has shown great difference.

Fifty per cent. are living and of the fifty per cent. who have died, the average length of life after the onset of obstructive symptoms has been four years and eight months.

If any conclusions could be drawn from these cases, it would be summed up about as follows:

Fifty per cent. of unoperated patients will die within five years from the onset of obstructive symptoms where catheter life is not necessary. The beginning of catheter life shortens this expectation of life almost fifty per cent. (two years and eight months) and increases the mortality to sixty-six and two-thirds per cent. within the shortened period.

The average length of life of the cases of carcinoma have been thirteen months from the onset of the symptoms.

Group II. Cases of Prostatic Obstruction Subjected to Operation

This group includes one hundred and ten cases, operated upon since 1909, where it has been possible to follow the operative result from the time of operation to the present. Among the living, no case has been included who has not lived at least one year from date of operation.

With the exception of three patients operated upon by the perineal method, suprapubic intraurethral enucleation of the prostate has been the operation of election. No two-stage operation has been included in this group.

Ages:

Under 50 years of age	5
From 50 to 60 years of age	26
From 60 to 70 years of age	57
From 70 to 80 years of age	16
From 80 to 90 years of age	6
	110

Thirty-six patients have suffered from primary symptoms only, and seventy-four from primary and secondary. Forty-one had been living catheter lives, exclusive of those who have had the catheter used in the treatment of the bladder and kidneys preparatory to operation.

Pathological changes in the gland:

Symmetrical adenomatous hypertrophy	62 cases
Typical median lobe obstruction	18 cases
Fibrous	17 cases
Carcinoma	10 cases
Tuberculosis	2 cases
Calculus	1 case

Complications:

Calculi were present in	14 cases
Strictures of the urethra in	3 cases

Strictures of the urethra complicated the case of calculous prostate.

One case of median lobe obstruction in a Chinaman was complicated by urethral strictures. (Perineal operation.)

One case of symmetrical hypertrophy was complicated by strictures.

A primary urethrotomy had been performed four years before the prostatectomy. Recurrent vesical calculi were present before and after urethrotomy. There has been no recurrence of calculi following prostatectomy during a period of four years.

The operative deaths:

Exclusive of the ten cases of carcinoma, there have been seven deaths occurring in from twelve hours to one week following operation.

Patient	Age	Time after Operation	Cause of Death
H–L	73	12 hours after operation	Shock
M–O	68	12 hours after operation	Shock
M–T	80	12 hours after operation	Shock, Postoperative Hæmorrhage
P–E	58	5 days after operation	Anuria
P–R	71	5 days after operation	Pulmonary Embolus
P–H	63	5 days after operation	Pulmonary Embolus
B–D	65	7 days after operation	Anuria

The patient who died from shock and hæmorrhage had a greatly enlarged prostate removed and subsequent continuous irrigation of the bladder was carried out by means of an in-

dwelling catheter and suprapubic tube. The continuous irrigation so masked the actual amount of hæmorrhage which the patient was having that the patient was *in extremis* before his danger was fully realized.

Up to this time I had used continuous irrigation in occasional cases but this experience made me discard its use. I believe it is safer to allow clots to form and thus check oozing, rather than to take the risk of dislodging them and exciting prolonged bleeding by constant irrigation. Since discontinuing the use of postoperative continuous irrigation there has been no instance of alarming bleeding.

The two patients who succumbed to embolism had had indwelling catheters inserted shortly after operation, in an effort to expedite wound healing. In both instances, the catheters were not well tolerated and induced very considerable vesical spasm.

I believe that during the straining produced by these spasms, clots were forced out of the pelvic veins into the general circulation with consequent death.

For these reasons it seems that the use of the indwelling catheter after operation should not be instituted until sufficient time has elapsed for the blood clots in the vessels to become well organized.

The above argument also applies to the question of immediate closure of the bladder and suprapubic wounds in an effort to obtain primary union, draining by indwelling catheter only.

I have been able to obtain primary union in three cases by such a procedure but it would appear that the added postoperative danger produced by an indwelling catheter inserted at an early period scarcely justifies itself.

The two cases who died from anuria presented features in common. They both belonged to that class of prostatiques suffering from overdistended bladders and in whom no infection had as yet taken place. Such a patient in my judgment is the poorest operative risk and requires the more pro-

longed preparatory treatment before operation should be undertaken.

Patients with a mild degree of cystitis often seem to have acquired a certain immunity of infection and as a rule do better after operation than those in whom the bladder is absolutely sterile.

Patients who have not acquired such immunity before operation and who are in addition suffering from renal disease, are apt to develop acute exacerbations of a nephritis when postoperative absorption takes place.

Two conditions probably are responsible for any pre-existing immunity to the dangers of postoperative absorption, namely, the blocking of the lymphatics by a long continued cystitis and the production of antibodies within the individual. Like observations are familiar in other regions of the body where surgery is undertaken.

Deaths occurring after convalescence from operation to the present time:

Exclusive of the cases of carcinoma, there have been six deaths occurring in from two months to three years after operation.

Patient	Age	Time after Operation	Cause of Death
D–E	71	2 months	Acute Gastroenteritis
S–N	73	4 months	Endarteritis, Nephritis
G–N	65	18 months	Endarteritis, Nephritis
A–S	69	2 years	Apoplexy
W–R	69	2 years	Endarteritis, Nephritis
H–Y	63	3 years	Diabetes

With the exception of the patient who died of acute gastroenteritis, all of the cases in the above list suffered from advanced kidney disease prior to operation. Each had been upon catheter life before operation and manifested severe secondary symptoms.

Operative deaths, Carcinoma of Prostate:

Patient	Age	Time after Operation	Cause
S–D	66	1 day after operation	Hæmorrhage and shock
P–T	65	3 days after operation	Diabetic coma

Deaths after convalescence from operation: Carcinoma.

Patient	Age	Time	Cause
B–L	56	4 months after operation	Marked cachexia
M–D	61	7 months after operation	Marked cachexia
C–K	76	10 months after operation	Marked cachexia

The patient living ten months had complete urinary retention before operation. After operation to the time of death, he voided without obstruction.

Of the five patients still living, the average time since operation is two years. One patient is alive five years after operation. In all recurrence has taken place but operation has added so great an amount of comfort to each individual that its performance has been justified.

The patients from whom tubercular prostates were removed are alive at three and two years after operation.

Both are in good general health.

Of the one hundred patients operated for benign hypertrophy, eighty-seven are alive and completely relieved from obstructive symptoms at periods ranging from four years to one year.

Postoperative urinary incontinence is an unknown accident following a properly performed suprapubic enucleation of the prostate.

DISCUSSION

Dr. Francis S. Watson, of Boston: I do not know if I quite correctly understand Dr. Cabot's views with regard to the conservative character of Dr. Young's operation, for in my practice I have not thought it more destructive than other operations, as, if I follow him rightly, Dr. Cabot has claimed it to be. I have for some years done Dr. Young's operation in alternation with that one with which I have been most familiar, namely the median endo-urethral method with which the endo-urethral method, and indeed have believed that as he performs methods, and I have alternated recently this operation with Dr. Young's for the purpose of comparing their advantages and disadvantages. I have not thought that Dr. Young's operation was more destructive than the endo-urethral method, and indeed have belived that as he performs it in many cases, at any rate, the prostatic urethra is spared injury as well as the ducts, I have not preferred the median endo-urethral operation, therefore, because of its doing less injury to the parts, but merely because I think I can do it more readily and more rapidly, and have been able to see no difference in the results as compared with those I have obtained by using Dr. Young's method. I do believe that the method that I have employed so much more frequently than others, I mean the endo-urethral one, is in fact a much more rapid one than is the operation of Young, and I do not find any advantage in having the field of operation before the eyes, as one has it in Young's technique, for I know that my sense of touch in this operation is more unerring than that of sight, and that I can rely upon it better, so that sight in this particular operation is not of advantage to me in so far as enucleation is concerned. In fact I frequently do that part of the operation with eyes closed. I do not think that the injury which I always have purposely inflicted upon the sides of the prostatic urethra in using the endo-urethral method, is objectionable, for the repair of the torn canal takes place so soundly that stricture is a very rare post operative complication. I used to believe that I injured the ducts in using the endo-urethral method until I examined a post mortem specimen in one of my cases and found them intact and learned in later cases that the power of ejaculation had been preserved, though I have never learned that the ejaculated fluid contained spermatozoa. I think that as Dr. Young does his own technique he very often avoids injury to the urethra, though this is not invariably the case, which he freely states in the reports of a certain number of his cases.

In regard to what Dr. Cabot has said about hæmorrhage and sepsis, I was somewhat surprised. I have not done many suprapubic operations, as a matter of fact I think not over forty, but I have never had but two operations of prostatectomy in which hæmorrhage played a part of a serious sort at or after the operation. I packed once in a suprapubic operation, and once in a perineal operation, because of serious hæmorrhage, the patient in the latter case I lost from shock and hæmorrhage; with these two exceptions I have never seen hæmorrhage severe enough to give me any anxiety. I have lost but one patient from sepsis and that was after a Bottini operation. Uræmia, embolism, and pulmonary post operative complications have been the fatal elements in my cases.

Dr. George K. Swinburne, of New York: I only wish to speak of catheter life. Of course, we all know that the introduction of a patient to catheter life is a very serious matter, but in the early days I had three cases who absolutely refused operation, who lived in catheter life, two of them for twelve years when they passed from observation, and one for fifteen when he died following traumatism caused by one of my assistants at the dispensary. He had a hæmorrhage, was sent into the hospital, and died there at the age of eighty-five of bladder infection. They were all kept on urotropin during the entire time. They came to the dispensary about once a week. Their bladders were washed out at first with silver nitrate, and afterwards I used installations of argyrol and left it in the bladder. I furnished them with catheters, and they always brought their catheters to the dispensary with them, and I looked them over to see that they were all right and taught them how to boil them. One of these cases was 65 and two were 70 years at beginning of treatment; under catheter life and urotropin there was no deterioration in their condition during that period.

As regards the two step operation, very recently I had an old man, who was very feeble, with complete retention, his heart was bad, he had emphysema, his kidneys were badly damaged, but we did a suprapubic under cocaine, and ten days afterwards I got Dr. Jerome Lynch to try his method of local anæsthesia through the sacral canal, and this proved at the time inefficient for the suprapubic wound. As soon as the finger was inserted in the suprapubic wound the man had so much pain that we gave him light chloroform anæsthesia, and after enucleation he went back to bed, and in ten days was up and around the ward. He was ready to go home at end of the third week but his wife furnished him with a

stuffed chicken neck and he died of acute indigestion forty-eight hours after that.

DR. KEYES: Dr. Chetwood, who had to leave, asked me to say that he understood Dr. Pedersen to remark that he did a suprapubic operation preliminary to a perineal prostatectomy. I can vouch for the fact that when Dr. Chetwood does a preliminary operation he does it in the hole which he intends subsequently to use for the removal of the prostate, that is, a suprapubic preliminary to suprapubic prostatectomy, and perineal preliminary to a perineal prostatectomy.

DR. PEDERSEN: I shall be glad to make the correction to which Dr. Keyes has called my attention. Equally so to correct a misquotation from Dr. O'Neil. In both instances, I seem to have misread my collator's abstracts.

DR. HUGH H. YOUNG, of Baltimore: These certainly have been five very interesting papers, and I assure you I have enjoyed them regardless of the strictures upon the operation I employ.

I agree fully with Dr. Keyes that the size of the prostate has nothing to do with the degree of obstruction. The largest prostate I ever removed, weighing 300 grammes, caused no residual urine, and the patient was operated on on account of recurrent hæmorrhages from the prostate. I think that the obstruction depends a good deal upon the tension of the capsule of the prostate. Quite frequently on rectal examination you will find a very large prostate with a wide groove between the lateral lobes in which there is little obstruction. Dr. Keyes' remark that the principal obstruction is usually at the vesical orifice is true, and I feel quite sure that the occasional failures of the perineal operation are due to the fact that the operator, after removing the lateral and median lobes, fails to investigate the internal orifice. For a long time I have urged the necessity of inserting a finger and feeling the orifice, and occasionally one will find a pedunculated lobe which he has missed, or a contracted vesical orifice which needs dilatation or division.

I am very glad to hear that Dr. Lowsley's research has borne such excellent fruit. It was undertaken at my suggestion, because I felt that the premises on which the papers of Freyer and also those of Zuckerkandl and Tandler were based were erroneous.

Long ago I called attention to the subcapsular transverse layer of gland tissue behind the hypertrophied lateral lobes, and have asserted that when one makes the two lateral capsular incisions he must not begin his blunt dissection immediately beneath the posterior capsule, but in

front of this thin layer of gland tissue, where he will at once come upon the capsule of the hypertrophied lateral lobe. While Dr. Cabot is correct when he says we do go through some normal prostatic tissue to reach that point, at the same time we do not remove any of it. I believe a great many people have had trouble in trying to shell out the prostate completely from behind because they have not gone through this subcapsular tissue, but have begun the enucleation before they reached the hypertrophied lobe. This posterior layer of tissue (it is not a lobe) almost never hypertrophies.

Dr. Cabot objects to my calling this a "conservative operation." Perhaps the term "conservative" is not so necessary now as it was when I gave it to it. At the time this operation was brought out the method employed in this country was a blind enucleation of the lateral lobes through a median perineal incision in which the triangular ligament and external sphincter were often injured, and the ejaculatory ducts destroyed.

The operation commonly in vogue abroad was one in which, after a good exposure of the prostate they wilfully divided the prostatic urethra in the median line, cut away the ejaculatory ducts, attempted to ligate them posteriorly (Albarran even ligating them in the groin) to prevent epididymitis. Besides that they quite intentionally incised the median portion of the prostate with the internal sphincter. What I was attempting to do was to bring out a procedure which would not mutilate these non-obstructive anatomical structures. Therefore, it was called conservative. The aim of the operation, therefore, was to go back of the bulb, which is a very hæmorrhagic structure, back of the transversus perinei muscles, the triangular ligament, and the external sphincter, and by simply dividing the central tendon, to expose the prostate from behind, so as to get at it where there were no important anatomical things in the way.

The invention of the tractor made it possible to draw the prostate so well into the perinæum that you could carry out what procedure you wished. I chose to preserve the ejaculatory ducts and if possible the prostatic urethra and internal sphincter.

As to the preservation of the urethra; in large prostates the urethra being greatly stretched and thin, not infrequently a portion of the mucous membrane comes away or it is torn. In the smaller prostates I wish to affirm that in the majority of cases no mucous membrane is removed. If anybody wishes to verify this they can come over and see the specimens.

In regard to the ejaculatory ducts, it is undoubtedly true that it is rather difficult to remove them in an enucleating operation. The ejaculatory ducts are surrounded by a sheath of fibrous tissue, and unless you use scissors you almost never remove them. In over six hundred specimens examined I do not believe there have been more than two or three in which we have found even one ejaculatory duct, and in these instances I used scissors. The ejaculatory ducts take care of themselves. The fact that I was able to preserve these various important structures, at a time when some or all of them were injured or destroyed by the other methods of perineal prostatectomy certainly justified my use of the term "conservative perineal prostatectomy."

Suprapubic prostatectomy can also be done conservatively, in comparison with the very radical method of Freyer in which the anterior commissure as well as the posterior urethra is torn away with the lateral and median lobes in one piece. To show that this method is too destructive it is only necessary to view the transactions of the last International Congress of Urology where some cases of complete obliteration of the posterior urethra, following this procedure, were reported.

By tearing through the mucous membrane on the anterior surface of the median lobe it is usually possible to separate the urethra from the median and the lateral lobes (working from above downward, the opposite of the intraurethral method of Squier). The three lobes can then be enucleated and removed, generally in one piece, and with no attached mucosa. The ejaculatory ducts are also uninjured by this method of suprapubic prostatectomy which I have employed since 1898. It is probably easier in some large intravesically projecting hypertrophies to enucleate them suprapubically, but the convalescence is longer, the hæmorrhage greater, and the mortality higher, and this forces me to do perineal prostatectomy in almost all my cases. I prefer to work a little harder in these great hypertrophies and give my patients the benefit of an easier convalescence. Those unused to the perinæum, or who do a bungling destructive operation should by all means use the suprapubic route. But some of these patients are in pretty bad shape, some of them are very old, some of them are desperately sick, and I cannot fail to give them what I think is the operation of the lowest mortality, although it does give us more work at times, and is a more difficult operation to learn.

But the fact that about 20 per cent. of the cases are carcinomatous, and that carcinoma can be handled far more satisfactorily through the

perinæum, should lead every genito-urinary surgeon to try to learn the more complex anatomy of the perinæum and to perfect his technique.

The increasing necessity for operations in chronic prostatitis and seminal vesiculitis which can only be handled through the perinæum is another cogent reason for not reducing perineal prostatectomy to a mere memory.

Besides carcinoma, there are undoubtedly a lot of prostates in which the internal sphincter is not at all impaired, where the prostate is not an intra-vesical thing at all, but extra-vesical, and therefore it seems a shame in those cases where the sphincter is normal to go in and tear out the gland through a perfectly normal sphincter. Some cases can be done more easily suprapubically, but I still assert that the mortality is and will be less perineally, there will be less absorption, less infection, they will be out of bed sooner, and your patient will be walking around in one-third the time.

For all round usage, large and small hypertrophies, the cancer, and the inflammatory cases, the perineal route is by far the most generally acceptable and satisfactory.

When someone is able to show 128 consecutive suprapubic prostatectomies without a death, I may consider abandoning the perinæum.

Dr. Francis R. Hagner, of Washington: I have seen lots of men do Dr. Young's operation supposedly, and a large percentage of men do not do it the way he does. I think that any man who has seen Dr. Young operate will agree to that. But I do think that one of the things that have given Dr. Young his wonderful success in these cases is his very careful pre-operative and post-operative treatment. He knows more about that than any of us, and he is mighty careful to get them in the best possible condition before operation.

I used to be absolutely wedded to the perineal operation. I do both now.

As to the operation of prostatectomy under spinal anæsthesia. My good friend Dr. Cabot will tell you these cases do not have shock. I had the pleasure recently of seeing some of his operations under cocaine anæsthesia. If I were to have my prostate taken out, I would take nitrous oxide and oxygen. I may be absolutely mistaken, but those patients looked shocked to me. As far as I understand shock they are shocked by spinal anæsthesia. I may be absolutely wrong.

There is one point in the use of Dr. Young's instruments, that is, of the prostatic incisor, I wish to bring out:

The use of this incisor often facilitates a suprapubic prostatectomy, especially those cases of small hard prostates with a thick fibrous capsule, by making it easier to get your finger through and under the capsule for enucleation.

Dr. R. F. O'Neil, of Boston: I should like to say a word in answer to Dr. Hagner in regard to spinal anæsthesia. It is perfectly true that the patient he saw operated on in Boston did vomit and presented an appearance of shock; this, however, was only temporary and the patient was all right shortly after. While these phenomena occasionally occur they are by no means constant and we have successfully employed spinal anæsthesia so many times for prostatectomy, stricture, cystoscopy, and other operations where a general anæsthetic is undesirable for one reason or another that we consider it of the greatest value in genito-urinary surgery.

Dr. Arthur L. Chute, of Boston: In my opinion spinal anæsthesia is perfectly marvelous for prostatic cases especially. It is true that patients not infrequently vomit after it, they may be troubled with headache as well, but the greater number have neither. At times patients who have had spinal anæsthesia do look pallid—uncomfortably so, but it will be found that the pulse is perfectly good. The great advantage is that in the patients whose renal function has been embarrassed by back pressure we can use spinal anæsthesia without further crippling the kidneys. I have used it a considerable number of times and have never seen any alarming symptoms from its use. I feel it should be the anæsthetic employed in all prostatic operations where the patient's renal function is below normal.

Dr. Hagner: The gentleman who first used spinal anæsthesia on prostate cases was Dr. Goodfellow. He came here and told me that he had had seventy-five cases without a death. He was using cocaine. He operated on two of my cases. The residents were up with one case all day and all night, his pupils were widely dilated, and I never saw a man in worse shock. He died in a week. The other man was operated on under spinal anæsthesia, and he lived four days. He used ordinary cocaine.

Dr. Louis E. Schmidt, of Chicago: A word in regard to spinal anæsthesia. I do not understand why all of a sudden it should be taken up again. I think for the past five years a great many people have used it and statistics have not shown any reason to make any unusual claim for it. I was accustomed to use it in prostatectomy and perineal work,

as far back as 1906. I cannot say that my results were any different then than they are now. I agree with what Dr. Hagner says as far as the character of the deaths are concerned. They were the same with spinal anæsthesia as with any other method of anæsthesia.

I would like to say one word in regard to hæmorrhage immediately following operation. As far back as five years ago I tried to stop hæmorrhage with suturing, but my experience was that any number of complicating conditions set in following suturing. I do not know why, but I can recall in the practice of others many deaths, apparently with abdominal symptoms, following this suturing, that had been advised by Kolischer of Chicago five years ago. I have been in the habit of packing without any hesitancy. I have had a series of seven successive cases where I have packed in every instance, and I think if the packing is done with a certain degree of care, and removed at the proper time, even without the aid of the tube that the Doctor referred to,—I see no objection to the packing coming in contact,—it may be theoretical not to do so, but in these cases I find that the wound heals just as rapidly as if the tube had been used, and in most instances the suprapubic wound heals far more quickly than if a tube is used; it granulates more quickly. I have packed at least fifty bladders from above, and most of those cases have healed as far as the bladder is concerned in the course of ten to fourteen days.

Dr. Keyes: I should like to add a brief word in favor of spinal anæsthesia. I am second only to the Boston school in my enthusiasm for it. Perhaps it is because I learned from them that in the 150 or 200 cases in which I have given it I have had no serious complication or death. I think it is very superior to any form of general anæsthesia that I have used for these old men. I confess to not sharing the idea that you do not get shock with spinal anæsthesia. I think my cases get some shock, and some of my cases get the type referred to. When I give a patient a spinal anæsthetic I am particular about a great many details that I got from the Boston school. If those details are carried out I believe there is no danger. As soon as the patient is put on the table a hypodermic syringe is loaded with two grains of caffein, and if the pulse goes down the caffein is given. In order to stop that kind of shock I have recently resorted with considerable success to the giving of ether to the patient, telling him that the ether is given solely for the purpose of destroying his sense of pain, but that he will hear all that is about him. It has the effect of stimulating him slightly, and the still more important

effect of distracting his attention, and it has enabled me to do away with the caffein.

DR. CABOT: Dr. Young raised the question as to the amount of destruction of the posterior lobe. It seems to me that the immediate prompt closure which he describes cannot be expected, at least in the hands of most of us, because we must extract through the posterior lobe the lateral lobes and the median lobe, and in the process of extraction we lacerate the tissue to an extent that practically destroys it. I believe the operation destroys the posterior lobe very largely, though perhaps not infrequently leaving the ejaculatory ducts intact. I do not believe it a very important matter, whether or not the posterior lobe is destroyed, but I had always supposed that it was upon the preservation of these posterior lobe structures that Dr. Young based his term conservative. Now, if we remove the prostate by splitting the urethra as Dr. Young suggests, there is no advantage over going into the prostatic urethra by introducing the finger into the apex, and enucleating the lobes. The line of cleavage will come at this point quite as accurately as it can be made with the knife, the line of cleavage going between the lateral and posterior lobes. At the upper border where the posterior joins the median lobe it will break across, a point clearly made many years ago by Dr. Samuel Alexander.

I cannot avoid paying my respects to Dr. Hagner on the question of shock. There are two perfectly distinct kinds of shock under discussion. The kind I was discussing is operative shock, due directly to the operation. The type of shock to which Dr. Hagner refers is an entirely different matter. It is the shock which occasionally accompanies the withdrawal of fluid from the spinal canal and the introduction of any other fluid. You will occasionally get that shock, which accompanies changes of circulation around the cord. We get accustomed to this type of shock in spinal anæsthesia. I do not know how frequently we see it, perhaps once in fifteen or twenty cases. It can be avoided by the methods described by Dr. Keyes, and I think has no effect upon the operative result. It passes in the course of an hour or so, and does not carry with it the effect of operative shock.

AN EXPERIMENTAL STUDY OF THE ANTISEPTIC VALUE OF THE INTERNAL USE OF HEXAMETHYLENAMIN, WITH THE REPORT OF A SIMPLE CLINICAL METHOD OF QUANTITATIVE ESTIMATION OF FORMALIN

By Frank Hinman, A. B., M. D., of Baltimore, Md.

Read by Invitation

Introduction

HEXAMETHYLENAMIN is a very popular drug for internal medication. This popularity is more the result of doubtful clinical than of definite experimental findings. In fact, except as a urinary antiseptic by virtue of its being converted in the urine into formalin, there are very few facts warranting its internal use. For some time it has been known that hexamethylenamin, itself, has no antiseptic power, but that it is only through its being converted into formalin that any antiseptic benefit can be derived from its use. Apparently, very little has been known regarding the factors that bring about this conversion; for a great deal has been written in favor of the antiseptic value of hexamethylenamin in not only diseases of the urinary bladder and kidneys, but also in diseases of the gall bladder, the middle ears, the nose and accessory sinuses, and of all the serous surfaces, the meninges, the endocardium, the pericardium and the pleura, the foundation for which is the mere presence of the hexamethylenamin in the fluids of these tissues and some indefinite clinical facts.

This study was undertaken to find, if possible, some experimental basis for these many and various claims and the results may be subdivided, for the convenience of better consideration into the following several parts:

I. The chemical nature of formalin and of hexamethylenamin.

II. The germicidal and antiseptic values of formalin and hexamethylenamin.

III. Chemical tests for formalin in the urine of patients getting hexamethylenamin by mouth, with the report of a simple method of quantitative estimation by a modification of the Rimini test.

IV. The antiseptic value to the urinary system of hexamethylenamin by mouth, with an attempt to discover the important factors influencing this value.

V. A comparative study of the antiseptic values of some of the allied hexamethylenamin compounds.

Chemical Consideration

Formaldehyde, CH_2O, is a colorless gas, an oxidation product of methyl alcohol, CH_2OH. It is readily soluble in water or alcohol and formalin is the name given to a solution of the gas. It readily combines with many inorganic and organic substances. When treated with an excess of ammonia it will combine to form hexamethylenamin, according to the equation: 6 CH_2O plus 4 NH_3 equals $(CH_2)_6 N_4$ plus 6 H_2O.

Contrariwise, if hexamethylenamin is treated with an acid it is reconverted into formalin. These changes, however, are, as a rule, of gradual occurrence, and depend largely upon the degree of acidity, or of alkalinity, of heat, etc., and upon the percentage concentration. A strong neutral solution of hexamethylenamin will break down to a certain extent even at room temperature, as was shown by examining the stock solutions in the wards of the hospital, some of which that had stood several weeks showing a formalin content of about 1 to 8000. Formalin, therefore, and hexamethylenamin, are very unstable chemical compounds, and particularly so towards acids and alkalies.

In addition to this instability there are certain chemical facts relative to formalin that should be considered in a study of this kind. It would be unusual if the body had no means of

protection against this primitive but very irritant organic substance. And the body does seem to protect itself, and through a process of synthesis. According to a well established hypothesis of v Bayer plants form carbohydrates by first synthesizing formalin from carbon dioxid and water. By a subsequent condensation of the aldehyde group they produce the simpler sugars. Butlerow[1] was the first who artificially prepared sugar by treating trioxymethylene, a polymer of formaldehyde, with lime water. Emil Fischer[2] and his pupils have since been able to synthesize most of the hexoses from formaldehyde, and this work indicates that formalin, or some of its polymers, may be the starting point in the synthesis of some of the glycogen in the body. The more recent work of K. Grube[3] confirms this hypothesis by showing through perfusion experiments on tortoise livers that formaldehyde acted as a glycogen-former.

For purely theoretical reasons, therefore, one would first not expect to find formalin in any of the body fluids except those of an acid reaction, and, if in the circulating fluids, one would further expect even this thus formed to be quickly synthesized, in the liver or elsewhere, into a harmless polymer. Our findings confirm, at least partially, this theoretical reasoning, and some of these questions will be considered more fully later.

Bacteriological

Loew and Fischer[4] pointed out as early as 1886 that formic aldehyde possessed powerful antiseptic properties, and since then an immense amount of work has been done by different investigators. The results are not uniform, but the differences may be explained by the great difference in the methods used, as well as by an undoubted difference in the power of resistance of the organisms used. For purposes of consideration the work divides itself naturally into that showing germicidal power on the one hand, and into that showing antiseptic power on the other. By germicidal is now generally under-

stood a complete death of the organism; by antiseptic, an inhibition of growth for a variable time while exposed to the action of the drug but with the ability to resume activity upon being removed to a favorable environment. Churchman[5] suggests the term "bacteriostatic" which better indicates the condition of antisepsis as just described. The following is an attempt to tabulate (Table No. 1) briefly the results showing the germicidal power of formalin from a review of the principle articles on the subject:

TABLE I

Tabulation of the germicidal power of formalin from the results of various investigators:

AUTHOR	B. Coli		B. Typhosus		Staphylococcus Pyogenes Aureus		Streptococcus	
	Time min. hrs.	Dilution	Time min. hrs.	Dilution	Time min. hrs.	Dilution	Time min. hrs.	Dilution
Slater & Rideal, 6	35	1/100	45	1/100	55	1/100	.....	.....
Aronson, 7	.....	.....	1 hr.	1/760	.....	.....	.....	.....
Ascoli, 8	.....	.....	.....	.....	30	1/20	.....	.....
Van der Linden & Buck, 9	15-30	1/20	15-30	1/20	15-30	1/20	15-30	1/20
Blum, 10	.....	.....	5	1/20	35	1/20	.....	.....
Anderson, 11	2	1/100	1½hrs.	1/100	1½hrs.	1/100	.....	.....
(Solution	1½ hrs.	1/50	50	1/50	50	1/50	.....	.....
contains 37.2%	40	1/33	30	1/33	30	1/33	.....	.....
aldehyde)	30	1/20	20	1/20	20	1/20	.....	.....

It is seen from this table that formalin is relatively slow in its germicidal action. It takes thirty minutes for a 1 to 20 solution to kill the Bacillus Typhosus, whereas 1 to 8000 bichloride of mercury solution will kill the same organism in one half that time.

But if formalin is allowed a longer time to act it is seen to be much more powerful, as is shown by the following table (Table No. II):

TABLE II

Tabulation of the antiseptic power of formalin from the results of various investigators:

(Growth was inhibited completely in dilutions given.)

Author	Staphylococcus Pyogenes Aureus	B. Typhosus	B. Coli	B. Anthrasis
Slater & Rideal	1/5,000	1/15,000	1/7,000	.....
Loew & Walter, 12	1/10,000	1/10,000	.....	.....
Trillat & Berlios, 13	1	1/20,000	1/33,000	.....
Schmitt, 14	1/20,000	1/20,000	.....	.....
Leroy des Barres, 15	.....	.....	.....	1/10,000
Schild, 16	1/	1/13,000	.....	.....
Anderson	1/3,000	1/3,000	1/3,000	1/4,000

Staph. pyog. albus.....1 to 3,000
Staph. pyog. citreus.....1 to 3,000
B. Dysenteriae (Shiga)...1 to 4,000
B. Pyocyaneus.....1 to 3,000
B. Cholerae.....1 to 6,000
B. Diphtheria.....1 to 5,000
B. Mallei.....1 to 6,000
B. Subtilis.....1 to 3,000
B. Proteus.....1 to 6,000

(Solutions contain 37.2% aldehyde, to compare with the above multiply by 3).
Anderson (these figures indicate complete inhibition for 15 days, and are therefore germicidal rather than antiseptic).

The above results show that a solution of formalin of from 1 to 8,000 or 9,000 up to 18,000 to 20,000, depending on the organism studied, will inhibit the growth of the organisms.

Original Work

It is seen from the above review that it is not as a germicide, therefore, that formalin is of value in urinary disinfection. We never get strengths in the urine of 1 to 100 and rarely, indeed, of 1 to 5,000. So that it is mainly as an antiseptic that formalin is of value. In order to determine more definitely this bacteriostatic value, and in order also to have a uniform method for comparison, the following bacteriological experiments were conducted:

Standard beef extract broth was made up with formalin in dilutions of from 1 to 4,000 to 1 to 100,000, 10 cc. of each dilution were placed in sterile test tubes and each inoculated with a standard 24-hour broth culture of B. Typhosus (Hopkins),

a four mm. loopful being used. These tubes were placed in the thermostat and transplants were made every 24 hours into sterile broth, each tube being observed at this time for visible signs of growth. The transplants show germicidal power; the observations of the inoculated dilutions for growth, bacteriostatic power.

Standard beef extract agar-agar was made up in the same way with formalin of from 1 to 4,000 to 1 to 40,000 dilutions, sterilized and slanted. Each formalin slant was then inoculated with the standard 24-hour broth culture of B. Typhosus, and every twenty-four hours for five days transplants were made from the surface of the agar-agar slants into standard beef broth. As before, the transplants, after being grown 48 hours, show germicidal power; the observations of the slants for growth, bacteriostatic power. Tables Nos. III and IV give the results of these experiments:

TABLE III

Bacteriostatic power of formalin to B. Typhosus:

Broth Formalin Dilution	24 Hours		48 Hours		72 Hours		96 Hours		120 Hours	
	Bact.	Germ.	Bact.	Germ.	Bact.	Germ.	Bact.	Germ.	Bact.	Germ.
1 to 4,000	o	o	o	o	o	o	o	o	o	o
6,000	o	o	o	o	o	o	o	o	o	o
8,000	o	o	trace	small	small	o	o	G	G	G
10,000	o	trace	small	G	G	G	G	G	G	G
15,000	o	trace	G	G	G	G	G	G	G	G
20,000	trace	G	G	G	G	G	G	G	G	G
30,000	small	G	G	G	G	G	G	G	G	G
40,000	G	G	G	G	G	G	G	G	G	G
50,000	G	G	G	G	G	G	G	G	G	G
100,000	G	G	G	G	G	G	G	G	G	G

o equals no growth.
G equals profuse growth.
trace equals just visible growth.
small equals slight growth.
(Each transplant grown 48 hours.)
(Dilutions from aldehyde, 100%.)

TABLE IV

Bacteriostatic power of formalin to B. Typhosus:

Agar-agar Formalin Dilutions	24 Hours		48 Hours		72 Hours		96 Hours		120 Hours	
	Bact.	Germ.	Bact.	Germ.	Bact.	Germ.	Bact.	Germ.	Bact.	Germ.
2,000	o	o	o	o	o	o	o	o	o	o
4,000	o	o	o	o	o	o	o	o	o	o
8,000	o	trace	o	o	o	o	o	o	o	o
16,000	o	G	G	G	G	G	G	G	G	G
20,000	trace	G	G	G	G	G	G	G	G	G
40,000	G	G	G	G	G	G	G	G	G	G

o equals no growth.
G equals profuse growth.
trace equals just visible growth.

Summary of the Antiseptic Power of Formalin

A review of the work of other investigators and our own experiments, indicate that formalin is a slow and relatively weak germicide, but that, even in high dilutions, it exerts a powerful inhibitory influence upon bacterial development. This power of inhibition varies with the different organisms. The staphalococci are the most, and the bacilli typhosus and coli almost as resistant, the streptococci and pyocyaneus next, whereas the proteus group, the diphtheria and pseudodiphtheria bacilli and subtilis and dysenteriæ bacilli are not so resistant to its action. A dilution of formalin of about 1 to 16,000 will cause a complete inhibition of the growth of the bacillus typhosus for 24 hours, a dilution of about 1 to 6,000 will completely kill the organism in that time, and a dilution of about 1 to 30,000 will definitely restrain its growth. But a 1 to 40,000 has no apparent effect, although, if the results are shown by means of plating and a systematic bacterial count, a definite effect by a slight diminution in the count is seen.

The urine should contain formalin in a dilution of 1 to 30,000, at least, therefore, in order to be of clinical value, and twice that strength, as it would then give complete inhibition,

is much to be preferred. A dilution of 1 to 6,000, in that it would be germicidal, would give the best effect.

Tests for Formalin and Method of Quantitative Estimation

In applying tests for their detection the marked instability of the two drugs, particularly with reference to acids and alkalies, should be given due consideration. The difficulty, in that an estimation of formalin alone is desired, is greatly increased by the associated presence of hexamethylenamin. It is not possible to use strong acids because the result is vitiated by the conversion of this substance.

In addition, the ease with which formalin combines with certain organic and inorganic substances is to be remembered. There are no doubt changes taking place in the urine that we know nothing about. Formalin, for instance, forms a soluble salt with uric acid, which suggested the use of hexamethylenamin in cases of urinary calculi, and as the urine contains many similar substances it is possible that in certain cases most of the formalin is present in the form of by-products which may or may not be antiseptic.

Qualitative Cases

Only brief reference will be made to a few of the qualitative tests for formalin that were used in the preliminary studies on hexamethylenamin.

Lyons'[17] modification of Hehner's[18] test for formalin is probably the most delicate and trustworthy where hexamethylenamin is known to be absent, but for this reason is not applicable to urine examinations. The concentrated sulphuric acid used converts, almost immediately, the hexamethylenamin present into formalin.

Lebbin's[19] test did not prove trustworthy in our hands, urinary substances in some way interfering with the reaction. Lebbin advised in 1899[20] distillation of the substances before

testing, but this process cannot be applied to urine examinations.

The amidol, or diaminophenol, test[21] is said to show formalin in as high dilution as 1 to 50,000,000. The coloring matter of the urine, however, apparently interferes with the color changes, and the test is not definite enough to be reliable, though beautifully obtained at times.

Shiff's[22] reaction is given not only by formalin, but by any aldehyde solution, and furthermore is objectionable because it contains strong sulphurous acid which converts the hexamethylenamin.

Neuberg[23] used diphenylenedihydrazin hydrochlorid to give a color reaction in milk examinations, and the test is characteristic for formic aldehyde, but the color change is yellow which renders the test valueless for the urine.

Jerrison's test[24], as modified by Nicalaier, has been used, particularly in Germany, but, as the test requires heating the solution with acetic acid, it will be given by hexamethylenamin as well as by formalin.

Of these tests Lebbin's and the amidol test are the only ones applicable to urine examinations. Hehner's test, however, was found of considerable negative value in showing the absence of both drugs. All of them are of value only qualitatively, and give no indication of the quantity of formalin present, the main object in view.

Quantitative Tests

An experimental study of some of the best considered quantitative methods of estimation was most discouraging, and for three main reasons:

1. The volatility and instability of formalin
2. The very small amount present, and
3. The associated presence of hexamethylenamin.

Distillation, as is demanded by some methods, is not possible, and, at best, would be a tedious process. Remijn's[25] cyanide method is precluded by the use of nitric acid, and the

same author's iodometric method,[26] calls for concentrated hydrochloric acid. The volumetric methods of Blank and Finkenbeiner,[27] and of Legler,[28] are not open to the above objection. By the former method a carefully weighed amount of urine is made strongly alkalin with normal sodium hydroxid, and neutral peroxid of hydrogen is added drop by drop until the reaction is completed (formalin being converted into sodium formiat). The excess of alkali is then titrated with normal sulphuric acid. In the latter method, standard ammonia is added in excess. The resulting hexamethylenamin is neutral (phenophthalein as indicator), six molecules of formaldehyde needing four of ammonia. The excess of ammonia is titrated with standard acid. These volumetric methods may sound feasible theoretically, but in their practical application there are a great many difficulties, and urinary acidity is the greatest of these. Besides, there are many possible chemical changes other than the ones desired that may occur and vitiate the results. Such known methods as the above are, therefore, impractical and untrustworthy for quantitative determinations of formalin in the urine.

Quantitative Method of Estimation

Rimini[29] in 1898 published a phenylhydrazin-nitroprussid test for formalin as particularly applicable to food stuffs, and it has since been found to be a very reliable test, provided certain precautions are observed. Anderson[11] reported it as one of the most reliable tests for formalin, and last year Burnham applied it to urine examinations. The test will not react with solutions of hexamethylenamin provided they are fresh. It is not given by sodium formate. And in no case will it fail to react with known formalin, provided the proportions are rightly adjusted and the formalin not too dilute nor in a too alkaline solution.

The directions given by Rimini are: "to 15 cc. of the substance are added successively 1 cc. of a dilute phenylhydrazine

hydrochlorid solution, a few drops of a fresh sodium nitroprussid solution and a few drops of caustic soda solution."

Burnham in applying the test to urine, modified it as follows: "to 10 cc. of the specimen add three drops of a 5% phenylhydrazin hydrochlorid solution and then three drops of a 5% sodium nitroprussid solution; then add two to three drops of a strong solution of sodium hydroxid, or a sufficient quantity to make the liquid alkaline."

In some observations as to the reliability of this test it was seen that there existed a definite relationship between the dilution of the formalin and that of one of the reagents, phenylhydrazin; the more formalin present, the less phenylhydrazin needed to give the reaction, and vice versa.

In order to definitely establish this relationship known dilutions of formalin were tested with varying known dilutions of the test drugs, and the results charted. These charts offer an approximate quantitative scheme of estimation which recommends itself because of its simplicity, and of its being the only method applicable.

The characteristic reaction, when the proportion of the test drugs to the percentage of formalin present are rightly adjusted, is the appearance of a dark blue or purple cloud on the addition of the alkali which cloud quickly goes into solution leaving a deep green changing into a brownish yellow or clear yellow solution (rarely red). A yellow, or brown to yellow, reaction is obtained where there is no formalin, or a very small trace. A green to yellow, or a brown-green-yellow, reaction is given with dilutions of from 1 to 70,000 to 100,000 but this reaction is not to be depended upon, and therefore should not be used.

The precautions to be observed in making the test are as follows:

1. Both test drugs are unstable when in solution. The phenylhydrazin forms a brown precipitate, or crystalizes out in the strong solutions, and the nitroprussid turns from a clear brown to a cloudy green or blue solution, each in a short

time. The only way to control this is by making up fresh solutions whenever these changes occur, which is usually about every third or fourth day. It was found very convenient to have 0.5 gram powders of the drugs weighed out ready for use, and the dilutions could then be quickly made after the following scheme:

Powders	Water	Dilution
2	10 c.c.	1 to 10
1	50 c.c.	1 to 100
1 to 100 solution		
5 c.c.	5 c.c.	1 to 200
4 c.c.	12 c.c.	1 to 400
2 c.c.	10 c.c.	1 to 600
2 c.c.	14 c.c.	1 to 800
1 c.c.	9 c.c.	1 to 1,000

2. Extreme care must be used in keeping the two drugs free of contamination with each other (as by using the same pipette). This will destroy the reaction.

3. The urine to be tested should always be warmed to about body heat.

4. Three to four c.c. of urine were found more convenient, and gave as uniform results as when 10 c.c. were used.

5. Several seconds (ten to fifteen) allowed from the time of adding the drop of phenylhydrazin and of nitroprussid before making the solution alkalin will often give a positive test when otherwise negative.

6. It is best not to shake the test tube at any time.

7. Allow the test drops, one only of each solution is used, to fall directly on the surface of the urine, and not to run down the sides of the tube.

8. In making alkalin, however, allow the few drops of sodium hydroxid to run slowly down the side of the test tube.

9. A urine should not be pronounced negative until after a control test using two drops of phenylhydrazin, in place of one drop, has been tried.

The following tables, V to XII inclusive, show the reactions for known dilutions of formalin with the different dilu-

tions of the test drugs. The formalin solutions were made up in fresh acid urine so as to simulate conditions for subsequent urine examinations. Control tests with water solutions gave similar tables.

TABLE NO. V

Formalin solution, 1 to 10,000.

PHENYLHYDRAZIN HYDROCHL									
1,000	123	123	423	23	23	3	3	3
800	123	123	123	423	23	3	3	3
600	123	123	123	123	123x	23	3	3
400	123	123	123	123	123	23	3	3
300	123	123	123	123	123	123	23	3
200	123	123	123	123	123	123	23	23
100	123	123	123	123	123	123	123x	23
50	123	123	123	123	123	123	123	23
20	123	123	123	123	123	123	123	123x
10	123	123	123	123	123	123	123	123
	20	50	100	200	300	400	600	800

Sodium Nitroprussid.

TABLE NO. VI

Formalin Solution, 1 to 20,000.

PHENYLHYDRAZIN HYDROCHLORID									
1,000	423	423	423	423x	23	3	3	3
800	123	123x	423	423	423x	3	3	3
600	123	123	123	423	423	3	3	3
400	123	123	123	123	123x	23x	3	3
300	123	123	123	123	123	23x	43	3
200	123	123	123	123	123	23	43	3
100	123	123	123	123	123	23	43	3
50	123	123	123	123	123	23	43	3
20	123	123	123	123	123	123x	23x	43
10	123	123	123	123	123	123	23	43
	20	50	100	200	300	400	600	800

Sodium Nitroprussid.

TABLE NO. VII

Formalin solution, 1 to 30,000.

PHENYLHYDRAZIN HYDROCHLORID									
1,000	423	423x	23	3	3	3	3	3
800	423	423x	23	3	3	3	3	3
600	123	423x	23	3	3	3	3	3
400	123	123x	23	3	3	3	3	3
300	123	123x	23	3	3	3	3	3
200	123	123	423	43	3	3	3	3
100	123	123	423	23	43	3	3	3
50	123	123	423	423	423	43	3	3
20	123	123	423	423	423	23	43	3
10	123	123	123	423	423	423	43	3
	20	50	100	200	300	400	600	800

Sodium Nitroprussid.

TABLE NO. VIII
Formalin solution, 1 to 40,000.

PHENYLHYDRAZIN HYDROCHLORID									
1,000	3	3	3	3	3	3	3	3	3
800	23	23	3	3	3	3	3	3	3
600	423	423x	3	3	3	3	3	3	3
400	423	423	43	3	3	3	3	3	3
300	423	423	423x	43	3	3	3	3	3
200	423	423	423	43	3	3	3	3	3
100	123	423	423	43	3	3	3	3	3
50	123	123	423	43	3	3	3	3	3
20	123	123	123	43	3	3	3	3	3
10	123	123	123	23	3	3	3	3	3
	20	50	100	200	300	400	600	800	

Sodium Nitroprussid.

TABLE NO. IX
Formalin solution, 1 to 50,000.

PHENYLHYDRAZIN HYDROCHLORID									
1,000	23	3	3	3	3	3	3	3	3
800	23	3	3	3	3	3	3	3	3
600	23	3	3	3	3	3	3	3	3
400	23	3	3	3	3	3	3	3	3
300	423x	3	3	3	3	3	3	3	3
200	423	3	3	3	3	3	3	3	3
100	423	23	3	3	3	3	3	3	3
50	123x	423x	3	3	3	3	3	3	3
20	123	423x	3	3	3	3	3	3	3
10	123	423	23x	3	3	3	3	3	3
	20	50	100	200	300	400	600	800	

Sodium Nitroprussid.

TABLE NO. X
Formalin solution, 1 to 60,000.

PHENYLHYDRAZIN HYDROCHLORID									
1,000	3	3	3	3	3	3	3	3	3
800	23	3	3	3	3	3	3	3	3
600	23	3	3	3	3	3	3	3	3
400	23	3	3	3	3	3	3	3	3
300	23	3	3	3	3	3	3	3	3
200	23	3	3	3	3	3	3	3	3
100	23	3	3	3	3	3	3	3	3
50	423	3	3	3	3	3	3	3	3
20	123x	423x	3	3	3	3	3	3	3
10	123	423	3	3	3	3	3	3	3
	20	50	100	200	300	400	600	800	

Sodium Nitroprussid.

TABLE NO. XI
Formalin solution, 1 to 70,000.

PHENYLHYDRAZIN HYDROCHLORID									
1,000	3	3	3	3	3	3	3	3	3
800	3	3	3	3	3	3	3	3	3
600	3	3	3	3	3	3	3	3	3
400	3	3	3	3	3	3	3	3	3
300	3	3	3	3	3	3	3	3	3
200	23x	3	3	3	3	3	3	3	3
100	23	3	3	3	3	3	3	3	3
50	23	3	3	3	3	3	3	3	3
20	23	3	3	3	3	3	3	3	3
10	23	23	3	3	3	3	3	3	3
	20	50	100	200	300	400	600	800	

Sodium Nitroprussid.

TABLE NO. XII

Formalin solution, 1 to 100,000.

PHENYLHYDRAZIN HYDROCHLORID	Sodium Nitroprussid 20	50	100	200	300	400	600	800
1,000	3	3	3	3	3	3	3	3
800	3	3	3	3	3	3	3	3
600	3	3	3	3	3	3	3	3
400	3	3	3	3	3	3	3	3
300	3	3	3	3	3	3	3	3
200	3	3	3	3	3	3	3	3
100	3	3	3	3	3	3	3	3
50	43	3	3	3	3	3	3	3
20	23x	43	3	3	3	3	3	3
10	423x	43	43	3	3	3	3	3

1 equals blue cloud.
2 equals green colored solution.
3 equals yellow solution.
4 equals brown solution.
123 equals the characteristic blue-green-yellow reaction.
x equals a very faint or doubtful reaction.

These tables show a fairly uniform limit of reaction for the several formalin dilutions. A 1 to 10,000 formalin solution gives the characteristic blue-green-yellow reaction, 123, with 1 to 1000 phenylhydrazin and 1 to 20 nitroprussid, whereas a 1 to 20,000 solution will not give the reaction with these reagent dilutions, though it will give the 123 reaction when a 1 to 800 and a 1 to 20 respectively are used. The results may be represented as in Table No. IX.

TABLE NO. XIII

1,000	10	10						
800	20	10						
600	30	20	10					
400	30	.....	20	10				
300	30	.....	.....	20	10			
200	.....	30	.....	20	10	.....		
100	40	30	.....	20	.....	10		
50	40	30	.....	20	.....	.....	10	
20	50	40	.....	20	.....	.....	.....	10
10	60	50	40	.....	20	.....	.....	.....
	20	50	100	200	300	400	600	800

If stronger solutions of formalin than 1 to 6,000 are to be tested, the phenylhydrazin may be carried to a higher dilution. For practical purposes it is not necessary to have more than two dilutions of the sodium nitroprussid, 1 to 20 and 1 to 100, and five dilutions of the phenylhydrazin, 1 to 10; 1 to 100; 1 to 600; 1 to 800 and 1 to 1,000. The estimation is made by finding

the weakest dilution of the test drugs that will give the 123 reaction which necessitates making several tests on each urine. It was found convenient in the routine examinations to represent the results in the form of a fraction, the numerator representing the dilution of the phenylhydrazin and the denominator, that of the nitroprussid, thus:

10/20	equals a	1 to 60,000	formalin	dilution
20/20	"	1 to 50,000	"	"
100/20	"	1 to 40,000	"	"
600/20	"	1 to 30,000	"	"
800/20	"	1 to 20,000	"	"
1000/20	"	1 to 10,000	"	"
1000/100	"	1 to 6,000	"	"

In order to determine the reliability of the above quantitative method a few bacteriological controls were made. A urine containing sufficient formalin to give the 1000 to 100 test should inhibit all bacteriological growth. This was repeatedly shown to be the case by inoculating such a urine with a culture of B. Typhosus or Coli and allowing it to stand in the thermostat for a week, subcultures for that time almost invariably being sterile. A urine with such a test was also seen to stand for days exposed in the laboratory without undergoing ammoniacal decomposition.

The experiment to determine the bacteriostatic power of formalin to the B. Typhosus, as charted in Table No. III, was repeated by substituting for the broth formalin dilutions, the urines of patients on hexamethylenamin showing the different degree tests. The urines were obtained aseptically, and allowed to stand several hours so that the conversion of the formalin would be practically complete. The results of these bacteriological examinations are charted in Table No. XIV, and this table should be compared with Tables No. III and IV.

TABLE XIV

Antiseptic power of formalin-containing urines.

Urine Quantitative Test	Transplant Before Inoculation	24 Hours		48 Hours		72 Hours		96 Hours	
		Bact.	Germ.	Bact.	Germ.	Bact.	Germ.	Bact.	Germ.
1000/100	o	o	o	o	o	o	o	o	o
1000/20	o	o	trace	small	G	G	G	G	G
800/20	o	trace	small	small	G	G	G	G	G
600/20	o	trace	small	G	G	G	G	G	G
400/20	o	small	G	G	G	G	G	G	G
300/20	o	G	G	G	G	G	G	G	G
3	o	G	G	G	G	G	G	G	G
43	o	G	G	G	G	G	G	G	G

o equals no growth
G equals profuse growth.
trace equals just visible growth.
small equals very slight growth.
3 negative test for formalin (Yellow reaction).
43 idem (Brown-yellow reaction).

THE ANTISEPTIC VALUE OF HEXAMETHYLENAMIN IN THE URINE

Ever since Nicolaier[30] in 1895 first demonstrated formalin in the urine as a decomposition product, the internal use of hexamethylenamin, as a urinary antiseptic, has been almost universal. But its real value as such has never been known. Churchman in 1906[5] indicated its antiseptic value in an interesting clinical and bacteriological study which lead him to the conclusion that its effects are expressed in an inhibition of bacterial development rather than in a destruction of bacterial life. Nothing more definite appeared until last year when Burnham[31] upset our ideas somewhat by stating that on the customary doses of from 5 to 10 grains three times a day, not more than two patients out of ten would show any decomposition of the drug into formaldehyde at all, while about 60% would show it on a dosage of from 20 to 30 grains every four hours. These findings were very quickly confirmed by L'Esperance[32] and Jenness,[33] the former finding 52% formalin-containing urines in 250 cases, the latter only 47.2%, in 200 cases. Last month Smith[34] published observations on 50 cases (213 specimens examined) in only one of which did he fail to find formalin.

No attempt was made by any of these investigators to determine the quantity of formalin put out in a series of cases. And, with the exception of the observations of Smith on urinary acidity, the important factors that influence this quantitative output have not been definitely established.

The present study attempts to indicate the average quantitative output of formalin in the urine of patients getting hexamethylenamin, grs. XV, t. i. d., p. c., and to determine the factors of influence in this output. It is based upon the examination, by the modification of the Rimini test for quantitative estimations as above described, of 318 urines from 116 different patients. Each sample had also an estimation of its acidity, and a majority of the specimens had an Amidol or Lebbin test in addition to the Rimini. Every urine found negative to the Rimini test was examined by Hehner's method to show the presence or absence of hexamethylenamin. An analysis of the findings will be given.

Type of Cases

The patients with five exceptions were not normal cases, and may be classified according to diagnosis as in Table No. XV.

TABLE NO. XV

Classification of Cases by Diagnosis.

Normal	..	5
Kidney:		
Tubercular Nephritis	3	15
Unilateral, Nephrectomy	7	...
Stone in, Nephrectomy	2	...
Pyelonephritis	3	...
Bladder:		
Stone	2	...
Contracture of vesical neck	2	...
Cystitis	2	6
Prostate:		
Enlarged, benign	26	...
Carcinoma	6	...
Chronic Prostatitis	3	35
Tubercular Epididymitis	..	1
Hydrocele	..	1
Varicocele	..	2
Sarcoma of Testicle	..	1
Impermeable Stricture of Urethra	..	2
Medical	..	3
Surgical, general	..	17
Gynecological	..	24
		112

Significance of Disease of the Kidney

The kidneys of 33 of the 112 patients were definitely affected, as indicated by the phenolsulphonephthalein test of Rowntree and Geraghty.[30] A number of these gave extremely poor phthalein tests, three showing only a trace in one hour, and the appearance time being markedly delayed, in one not appearing for 55 minutes, in another for 62. The findings in the 44 cases in which phthaleins were taken may be grouped as follows:

An excretion of less than 10% in 2 hours:
4 cases: 2, 800/20; 1, 1000/100; 1, 1000/20

An excretion of between 10 and 20%:
5 cases: 1, 20/20; 1, 400/20 and 2, 1000/100; 1, 100/20.

An excretion of between 20 and 40%:
11 cases: 1, 50/20; 3, 100/20; 1, 200/20; 2, 400/20; 3, 600/20 and 1, 1000/20.

An excretion of between 40 and 60%:
13 cases: 1, 10/20; 1, 20/20; 2, 200/20; 1, 300/20; 2, 400/20; 1, 600/20; 1, 800/20; 1, 1000/20 and 1, 1000/100; 1 case negative.

An excretion of over 60%:
11 cases: 1, 20/20; 1, 50/20; 1, 100/20; 1, 200/20; 2, 400/20; 3, 600/20; 1, 1000/100 and 1 case negative.

These results do not indicate that disease of the kidney exerts any influence whatsoever upon formalin content in the urine.

Antiseptic Value of Formalin at the Level of the Kidneys

It has been generally believed that hexamethylenamin was converted into formalin at the level of the kidneys. Burnham and others even state that it is through the activity of the kidney cell itself that formalin is formed. Smith, however, attributed formalin conversion to the action of urinary acidity alone, and this is in agreement with the findings of this study. It has already been shown that disease of the kidney has no

influence whatever on formalin content in the urine. It was particularly desired, however, to determine, if possible, just what antiseptic value hexamethylenamin by mouth would have for kidney infections. To be of value formalin must be present in the urine in the kidney in amounts of 1 to 30,000 or greater. To determine this the ureters of patients on hexamethylenamin were catheterized and the specimens from each kidney were examined immediately, and these findings compared to those on the urine voided just before the cystoscopy. The results are charted in Table No. XVI.

Unfortunately, of these cases only one had formalin in the bladder urine in definite antiseptic amount, but, nevertheless the difference for the catheterized urine as compared to the bladder urine is striking. Only three of the thirteen bladder urines failed to show formalin, whereas of the 23 catheterized urines five only showed formalin, and these five the 10/20 reaction only. The eighteen negative urines all gave a positive Hehner's test and six of these eighteen a positive Amidol test.

While these facts indicate that the conversion of hexamethylenamin begins at the level of the kidneys, they as clearly indicate that the amount of this conversion is very slight, and even with an acid urine not enough formalin is formed at the kidney to be of any great antiseptic value, if of any, in no case here more than about 1 to 60,000.

The explanation for this is no doubt the lack of time necessary for formalin conversion in an acid medium, and particularly where the acidity and the amount of the drug (hexamethylenamin) present are not great. The hexamethylenamin when excreted from an alkaline blood is not allowed to remain at the level of the kidney long enough to give good conversion.

Antiseptic Value of Formalin in the Bladder: Only four of the 116 cases failed to show formalin, namely, cases Nos. 19, 20, 100 and 114. There is a reasonable doubt as to case No. 19 having received any hexamethylenamin. Cases 20 and 100 received their hexamethylenamin at 7 p. m. and the sample of

TABLE NO. XVI

Tabulation of results on urine obtained by ureteral catheterization.

	Bladder Urine				Ureteral Catheterized Urine					
					Right			Left		
Case	Quantitative Test	Amidol Test	Hehner's Test	Acidity	Quantitative Test	Amidol Test	Hehner's Test	Quantitative Test	Amidol Test	Hehner's Test
I.	3	pos.	pos.	ft. ac.	3	neg.	pos.	3	neg.	pos.
II.	10/20	.....	.....	ac.	.....	.....	.....	3	neg.	pos.
III.	100/20	.....	.....	ac	10/20	pos.	pos.	.....	.....	.....
IV.	200/20	.....	.....	ac.	3	neg.	pos.	3	neg.	pos.
V.	23	.....	pos.	ft. ac.	43	.....	pos.	3	neg.	pos.
VI.	3	.....	pos.	ft. ac.	3	.....	pos.	43	.....	pos.
VII.	20/20	pos.	pos.	ac.	423	pos.	pos.	423	pos.	pos.
VIII.	20/20	pos.	pos.	ac.	3	pos.	pos.	3	pos.	pos.
IX.	100/20	.....	.....	1.6	3	neg.	pos.	3	neg.	pos.
X.	200/20	.....	.....	4.3	10/20	.....	.....	10/20	.....	.....
XI.	1000/20	.....	.....	2.5	10/20	.....	.....	10/20	.....	.....
XII.	100/20	.....	.....	2.	3	pos.	pos.	3	pos.	pos
XIII.	10/20	.....	.....	0.7	3	.....	pos.	.....	.....	.....

Note:—Part of ureteral specimen of Case IV after standing 2 hours showed a 20/20 test; of Case I, made acid with acid sodium phosphate, in 24 hours a 10/20 reaction.

urine was taken 11 hours later, at 6 a. m. They received but the one does, and had but the one sample examined. One specimen only of case No. 114 was examined. The remaining 112 cases were positive at some one examination for formalin, and only six of these would have been negative if there had been only the first examination. The cases may be conveniently grouped according to the highest test given at any time, and the examinations also according to test reaction, as shown in Tables Nos. XVII and XIX.

From these tables it is seen that of the cases only 8, or 7%, had formalin in germicidal strength, and five of these eight had been fed on acid sodium phosphate, so that in only about 2% of the usual cases did the urine give the 1000/100 test at any one time. Twenty-eight cases, or about 25%, had formalin in amounts to furnish complete bacterial inhibition, and 62, or about 55%, of the cases gave at some one examination a 400/20 test or better, that is, had an antiseptic value equal to or greater than 1 to 30,000 formalin. Fifty of these cases gave a test lower than this as their high test. Forty-four per cent of the cases, therefore, at no time had formalin in amounts sufficient to furnish any antiseptic benefit.

Of the 318 examinations 113, or 36%, were definitely antiseptic, and of these, 53 specimens, or 17%, showed complete bacteriostasis and 16 specimens, 5%, were germicidal. While 201 specimens gave a reaction below the 400/20 test, 64% of the urines, therefore, possessed no antiseptic value.

Factors Influencing Formalin Content: There are several factors that appear from this study to have considerable influence upon the formalin content of the urine of patients getting hexamethylenamin by mouth, and they are of enough importance to deserve consideration. These factors are naturally of two kinds, namely, those that relate to hexamethylenamin excretion and those that relate to hexamethylenamin conversion, but they are all more or less interdependent and will be considered in general first and later summarized according to this relation.

TABLE NO. XVIII

Classification of cases according to highest test.

	Negative	10/20	20/20	50/20	100/20	200/20	300/20	400/20	600/20	800/20	1000/20	1000/100	Total
Number of cases.	4	12	4	3	20	9	2	16	18	10	10	8	116
												7% germicidal	
			54								28		
										25% completely inhibitory 62			
	44% without antiseptic value							55% with antiseptic value					

TABLE NO. XIX

Classification of examinations according to tests.

	Negative	10/20	20/20	50/20	100/20	200/20	300/20	400/20	600/20	800/20	1000/20	1000/100	Total
Number of cases.	36	44	11	11	58	40	5	32	28	20	17	16	318
												5% germicidal	
				205							53		
										17% completely inhibitory 113			
	64% without antiseptic value							36% with antiseptic value					

Influence of Urinary Acidity: In the earlier examinations the acidity was determined with ordinary litmus papers, and although the method itself was very unsatisfactory, it was very early seen that the amount of formalin in a urine was proportional to its acidity. Only two specimens turned red litmus blue, and both were negative for formalin. Both, however, gave a Hehner's test, as did all the 34 negative urines, thus showing that hexamethylenamin was being excreted, even though it was not being changed into formalin.

Titration Results with N/10 NaOH: In order to definitely determine the significance of urinary acidity to formalin content, 10 c.c. of each specimen were titrated against N/10 NaOH using phenophthalein as indicator. The acidity varied from 0.1 to 7.9 c.c., the average of the 231 estimations being 3.1 c.c. N/10 NaOH to 10 c.c. of urine. The average urinary acidity as found by Brown by this method was 2.5 c.c. The higher result in this series is accounted for by the fact that hexamethylenamin tends to increase urinary acidity and a number of the patients of the series had been fed acid sodium phosphate to increase the acidity of the urine. The findings with reference to the test reaction may be classified as in table No. XX, which shows very definitely that the acidity of the urine is an extremely important factor in the conversion of hexamethylenamin. Twenty-nine of the urines had an acidity of less than 1 c.c. and of these 29, 13 were negative for formalin and 12 others barely gave a test. There were two negative urines with an acidity between 1 and 2 c.c., whereas of the urines with an acidity above 2 c.c. all showed formalin, and with the exception of 6 cases, all showed a 1 to 40,000 test or better. There were 109 urines that gave the 1 to 30,000 test or better and of these 109, 100 had an acidity of 2 c.c. or better, and only 9 an acidity between 1 and 2 c.c.; none below 1 c.c. On the other hand, there were 95 urines that gave a test below 1 to 30,000, and of these 95, 57, or almost two-thirds, had an acidity below 2 c.c. This would indicate that a formalin content of antiseptic value cannot be expected with a urinary acidity below 2 c.c. of N/10 NaOH.

TABLE IX

Tabulation of results according to acidity and test reaction.

ACIDITY in $\frac{10}{N}$ NaOH	Test Reaction	Negative	10/20	20/20	50/20	100/20	200/20	300/20	400/20	600/20	800/20	1000/20	1000/100	Total
	0–0.5	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
	0–5–1	8	12	1	.....	2	.....	.....	1	.....	.....	.....	.....	24
	1–2	2	6	3	5	7	5	1	3	1	3	.....	1	37
	2–3	.....	3	.....	1	8	6	2	2	4	3	.....	4	33
	3–4	.....	.....	.....	.....	3	3	1	2	4	4	5	3	25
	4–5	.....	2	.....	.....	2	3	.....	5	5	3	5	3	28
	5–6	.....	.....	.....	.....	1	.....	.....	5	10	1	3	2	22
	6–7	.....	.....	.....	.....	1	1	.....	3	1	3	1	1	11
	7–8	.....	.....	.....	.....	1	.....	.....	3	1	1	1	2	9
	acid	2	15	7	5	31	22	1	8	2	2	2	.....	97
	ft. ac.	17	6	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	25
	alk.	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
	Total	36	44	11	11	58	40	5	32	28	20	17	16	318

The importance of urinary acidity for the conversion of hexamethylenamin in the urine may be demonstrated by the following observations:

1. The addition of normal acid urine of a patient not on hexamethylenamin to a faintly acid one of a patient getting the drug causes the formation of formalin where it had previously been absent.

2. The urine of a patient on hexamethylenamin, if acid, will give a higher test for formalin after standing than when fresh. This change on standing was repeatedly demonstrated and is a good way to determine whether a case is excreting hexamethylenamin or not. For example, a urine of case No. 12, at 11:30, when voided, was negative for formalin, but after standing till 3 p. m. it showed a 1 to 40,000 formalin content. A faintly acid or neutral urine, however, will show no increase in formalin on standing.

This increase on standing is an important factor to be considered in making tests. Every urine should be examined when fresh in order to be able to judge fairly its antiseptic value while in the bladder. This time factor will help to explain the low reading of a patient on forced water as compared to that of one without polyuria. But urinary dilution with a corresponding diminution in the acidity and in the percentage concentration of the drug, are probably more important. With a high acidity and good concentration a half hour is time enough for good conversion.

In cases of cystitis, therefore, in order to get the best results from hexamethylenamin therapy, the fluids should be partially restricted and the bladder emptied as infrequently as possible.

3. If hexamethylenamin is added to an acid urine it will be quickly converted into formalin. On the other hand hexamethylenamin added to a neutral urine will show none of this conversion.

4. The addition of acid sodium phosphate to the urine of a patient on hexamethylenamin, negative for formalin, will convert that present into formalin.

The addition of almost any acid will convert hexamethylenamin, showing that there is nothing specific in sodium phosphate. This latter was used because of its being the principal element of acidity in urine. It was also shown by tests with normal urines, that is without hexamethylenamin, that the sodium phosphate has nothing whatever to do with the test reaction.

5. Increasing, or decreasing, the acidity of the urine of a patient through his diet caused a corresponding change in the formalin of his urine. Feeding milk of lime (drams 2, t. i. d., P. c.) causes a marked diminution in urinary acidity, and, as in case 34, a complete disappearance of formalin from the urine.

Feeding acid sodium phosphate, on the other hand, increases the urinary acidity in cases where it is low, and in those cases very definitely increases the amount of formalin in the urine. This was tried in cases Nos. 11, 23, 30, 34, 35, 36, 61 and 64, and in each case there was a demonstrable increase in the formalin output, in five of the cases even to a 1000/100 test. It would seem, therefore, that by feeding acid sodium phosphate, or some such drug to render the urine acid, such as boric acid, benzoic acid or salicylic acid, every case that is tolerant to hexamethylenamin can be made to put out formalin in antiseptic amounts. The effects of any one of these acid producing drugs will wear off after a time due to body tolerance but when this occurs for any one it is possible in some cases to again raise acidity by substituting one of the other drugs in its place, and by thus alternating the use of them acidity may often be maintained for some time although not satisfactorily in all cases. It is not well to give the phosphate with the hexamethylenamin, since, as already shown, it has a marked tendency to convert this into formalin and might do so to such an extent in the stomach as to produce gastric irritation.

Influence of Gastric Acidity: Hexamethylenamin by mouth is partially converted into formalin in the acid contents of the stomach. The amount of this conversion depends upon the degree of gastric acidity, the amount of the drug exposed to the action of this acidity and the duration of this exposure.

In order to determine the significance of this formalin thus formed in the stomach, patients were given by mouth pure formalin solutions for several days and the urines of these patients carefully examined for both formalin and hexamethylenamin.

These urines were all uniformly negative even with the most delicate tests showing that the formalin taken by mouth was not being excreted either as formalin or as hexamethylenamin. What becomes of this formalin is not known. Formalin when taken in large toxic doses or when injected into the circulation directly as was done by Maguire[36] appears in the urine as formalin causing marked hæmaturia, etc. It is possible that the formalin taken in the dilutions given, and that converted in the acid stomach on feeding hexamethylenamin, is synthesized in the body to form glycogen as has been experimentally done by chemists as stated above in the discussion of the chemistry of the two drugs.

The blood of the patients being fed pure formalin was examined also with Hehner's, the Amidol and Rimini tests and in each case with complete negative findings which would indicate that the formalin had not been taken into the circulation as formalin nor been converted into hexamethylenamin in the alkaline medium of the intestines or of the blood.

Feeding Salol-Coated Pills: In order to avoid the effects of gastric acidity hexamethylenamin may be given in other ways than by the mouth. It is readily absorbed when given per rectum, and Gundrum[37] has given as much as grs. X, t. i. d. for two weeks hypodermatically. But these methods are not convenient for routine use. Ipecac is sometimes given in salol-coated pills so as to carry it beyond the stomach, the salol not being digested until it has reached the intestines, and

salol-coated pills of hexamethylenamin were similarly tried. In cases of hyperacidity there was a slight increase in the formalin content, but the difference was not great, not enough to recommend the method for routine use. It takes from two to three hours longer for the drug to appear in the urine and it seems to disappear sooner than when fed in the usual way. It is possible that considerable of it is lost through the bowel although the stools were not examined to prove this. Nevertheless in cases of gastric irritability this mode of administration is applicable.

Influence of the Size of Dose: In this study the dose of hexamethylenamin was uniformly grs. XV three times a day. In a few cases, however, this routine was varied for purposes of comparison. In case No. 36 it was increased to grs. XL without any increase in the formalin content until the acidity of the urine had been increased by feeding acid sodium phosphate. With the acidity below 2 c.c. NaOH the tests read from 10/20 to 100/20 for ten days. On giving sodium phosphate there was an immediate increase in the acidity with a corresponding rise in the test reaction, 800/20 to 1000/100 and this high reading persisted even though the acidity fell after five days to below 2 c.c. again, being 1.8 with a 1000/20 test on one day, and 1.7 with an 800/20 test on another. But in both of these cases the urine had stood about two hours after being voided before being tested. In another case grs. XXX were given with an increase in formalin content. The amount of hexamethylenamin excreted, the other factors being equal, appears to be proportional to the amount ingested, but a large dose is not effective unless accompanied with a urinary acidity greater than 2 c.c. NaOH. The value of smaller doses than grs. XV is very questionable. Larger doses should be given in cases of cystitis, and the drug can be given for months in fairly large doses with no untoward results.

Influence of Curve of Excretions: Formalin will begin to appear in an acid urine in amounts sufficient to be detected,

after the ingestion of XV grains, in from 25 to 30 minutes, and will have disappeared in from 8 to 16 hours. The height of excretion is reached in from 2 to 4 hours and is maintained for about 4 hours longer. A 6 to 8 hour interval of administration will give good results in routine use although a more frequent administration will give a higher concentration.

Summary of the Factors Influencing the Formalin Content in the Urine

I. Those factors relating to hexamethylenamin excretion:

First—The amount of the drug given will largely influence the percentage concentration on excretion, and the larger the dose the higher will this be. Large doses may be given with no bad effects in the majority of cases. Small doses are useless in most cases.

Second—The interval of administration should not be longer than eight hours and shorter periods will give a more continued maximum effect.

Third—The character of the changes that occur in the acid contents of the stomach may form an appreciable factor in cases of hyperacidity or of stasis in which there may be a considerable conversion of the hexamethylenamin. The amount broken up in the stomach is that much loss for subsequent conversion in the urine.

II. Those factors relating to the conversion of hexamethylenamin:

First—The degree of urinary acidity is the most important factor, and should be greater than 2 c.c. N/10 NaOH. It may be increased or maintained in some cases by feeding certain acid producing drugs of which acid sodium phosphate is the best. For all practical purposes it is only necessary to know the acidity of the urine to know whether formalin is present in that case in an antiseptic amount or not, provided the patient is getting large doses at regular intervals not greater than eight hours, and has no gastric irritation or polyuria.

Second—The duration of exposure to the influence of this acidity is of importance, so much so that on account of it the drug is of questionable use in kidney infections. And it becomes of particular importance in cases of cystitis or polyuria in which the patients void so frequently that time is not allowed for the conversion of the hexamethylenamin in the bladder in amounts to be of antiseptic value. In estimating the antiseptic value of a urine it should always be examined fresh and not allowed to stand before testing.

Third—The percentage dilution of the drug on excretion influences markedly the percentage concentration of the drug and the higher this is the more readily will conversion into formalin occur. A polyuria will largely offset the advantage of a large dosage through dilution.

A Comparative Study of the Antiseptic Values of Some of the Allied Hexamethylenamin Compounds

Hexamethylenamin is dispensed under many proprietary names, such as urotropin, formin, aminoform, etc. Certain of these are less irritant but none apparently liberate more formaldehyde than does the chemically pure drug. In addition to these there are a number of other proprietary preparations for which an action superior to hexamethylenamin is claimed, particularly by the manufacturers. Some of these salts of hexamethylenamin that were available were tested comparatively with hexamethylenamin.

I. Helmitol, a compound of hexamethylenamin with anhydro-methylen-citric acid ($C_6H_8O_7(CH_2)_6N_4$–$C_{12}H_{20}O_7N_4$) is said by some to be more prompt and energetic in its action than hexamethylenamin, acting equally well whether the urine be alkaline or acid in reaction.

A comparative study of this drug indicates that it is converted into formalin under the same conditions as is hexamethylenamin, that is, only in an acid medium. Furthermore, as shown in cases, nos. 4, 5, 23, 34, 35, and 42, it gave a

uniformly lower formalin content than did hexamethylenamin in the same cases.

II. Hexal, a compound of sulphosalicylic acid with hexamethylenamin, $((CH_2)_6N_4–SO_3H–C_6H_3(OH)COOH)$, splits up in the organism into sulphosalicylic acid and hexamethylenamin. In addition to the antiseptic action of hexamethylenamin Hexal through the action of the sulphosalicylic acid is said to have a decidedly astringent action upon inflamed mucous membranes and a very marked anæsthetic effect. Kowanitz (38) in a clinical study of the drug concludes that it increases diuresis makes an alkaline urine acid and has a marked sedative action, Boss (39), Frank (40), Seegers (41), and Beer (42), have all published clinical evidence in its favor. Our study of the drug was directed towards determing the amount of formalin put out after its administration as compared to that put out by hexamethylenamin. With the exception of one case (No. 9) there was no increase of the formalin content with it. Case No. 9 took hexamethylenamin badly, and was able to take Hexal with less disturbance. The other cases (Nos. 7, 16, 23, 29, 34, 35, 36, and 42) showed a decided lowering of the formalin content when Hexal was given. It would seem that there are some cases of cystitis in whom Hexal would be better borne, but in the great majority of the cases better results will be obtained by feeding the hexamethylenamin and salicylic acid separately.

III. Saliformin, Hexamethylenaminæ Salicylas, is a weak salt of hexamethylenamin and salicylic acid. $((CH_2)_6N_4C_6H_4$ OH–COOH), and does not differ in its action from a mixture of these two as it is mostly hydrolyzed into its constituents in the presence of water. Furthermore, the presence of the salicylic acid tends to convert the hexamethylenamin before absorption and weakens the value of the latter by that much.

IV. Myrmalyd is a combination of hexamethylenamin and of sodium formate. The latter is formed from formalin by treating with sodium hydroxide in much the same way that hexamethylenamin is formed by treating with ammonium

hydroxide. Sodium formate is not so readily broken down as is hexamethylenamin and treatment with the ordinary acids does not produce formalin. Feeding the drug, was followed by no liberation of formalin in the urine. Myrmalyd, therefore, can have no advantage over hexamethylenamin.

Summary: The allied compounds (Helmitol, Hexal, Saliformin, and Myrmalyd) do not give as good a formalin content as does hexamethylenamin. Hexal is of advantage in some cases of very irritable bladders.

Conclusions

First—The conversion of hexamethylenamin into formalin is a simple chemical process which will readily occur in an acid medium but will not occur in an alkaline medium.

Second—the amount of excretion in the urine is influenced by the size of the dose, the frequency of administration and by the changes that occur in an acid stomach contents.

Third—The amount of conversion into formalin in the urine is dependent upon the degree of urinary acidity, the duration of exposure to the action of this acidity, and upon the percentage concentration of the drug in it.

Fourth—Urinary acidity should be greater than 2 c.c. N/10 NaOH for 10 c.c. of urine in order to give formalin conversion in antiseptic amounts.

Fifth—A low acidity may be temporarily increased by feeding certain acid producing drugs, and this increase in acidity may often be maintained by giving these drugs alternately.

Sixth—A determination of urinary acidity, knowing the significance of the other factors, is all that is needed for the clinical control of hexamethylenamin therapy.

Seventh—Forcing water diminishes through dilution the antiseptic value of hexamethylenamin, and therefore, in these cases much larger doses should be given.

Eighth—The amount of conversion of hexamethylenamin in the acid contents of the stomach means that much loss for subsequent conversion in the urine.

Ninth—Disease of the kidneys has no influence, whatsoever, upon the formalin content in the urine.

Tenth—At the level of the kidneys hexamethylenamin, in doses of grains XV three times a day, has no antiseptic value, and to be of value in kidney infections much larger doses must be given.

Eleventh—In the bladder formalin is present in the urine in some amount in practically every case getting XV grains t.i.d.

Twelfth—A solution of formalin of 1 to 30,000, will give partial inhibition to bacterial growth for 24 hours, a strength of 1 to 16,000, will give complete inhibition and a 1 to 6000, will be germicidal in that time. (for B. Typhesus).

Thirteenth—A value of 1 to 30,000 was obtained in 36% of the urines, of 1 to 20,000 or stronger, in 17% and of 1 to about 6000, in only 5% of the examinations, and 64% failed to show formalin in any antiseptic value, therefore XV grains of the drug three times a day is too small a routine dose from which to expect a reasonable antiseptic benefit in every case.

Fourteenth—The weak salts of hexamethylenamin have no advantage from the standpoint of antisepsis ever the pure drug.

(I wish to express my gratitude to Dr. Hugh H. Young, for the privilege of making this study and to thank him and the Residents of the Johns Hopkins Hospital, Drs. Sladen, Heuer and Vest, for the clinical material.)

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AN OPERATION FOR URETHRO-RECTAL FISTULA: REPORT OF THREE CASES

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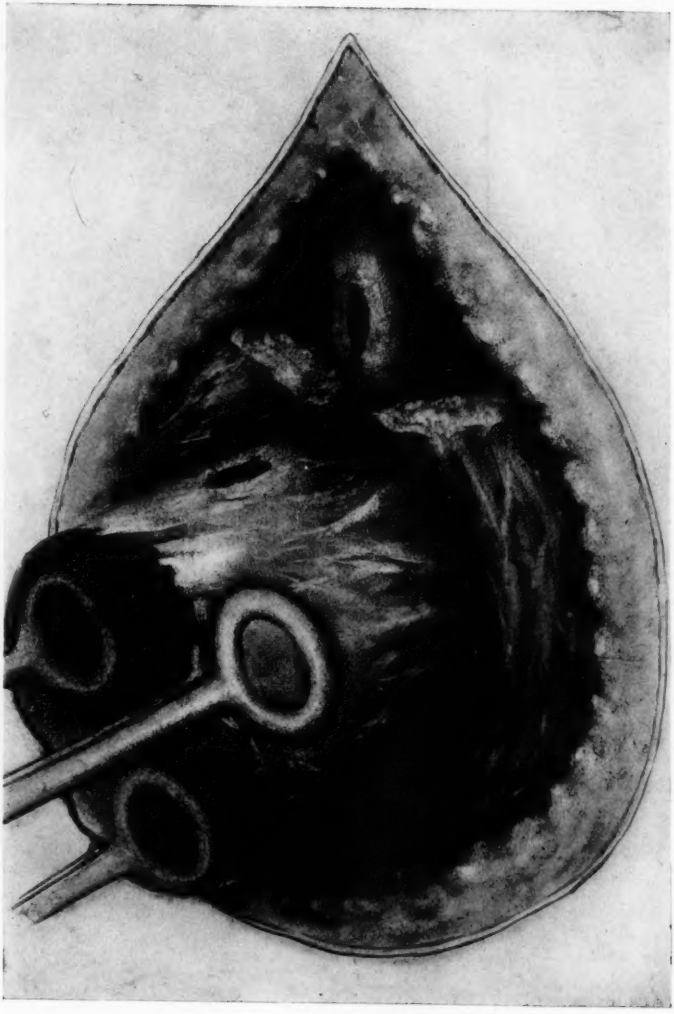
THE rather limited literature upon urethro-rectal fistula impresses strongly two facts: that such fistulæ are rare, and that they are most difficult to cure. From the writings of Astley Cooper down to the present these characteristics of the lesion are repeatedly emphasized. The truth of such observations is further evidenced by the various methods employed and by the failure of any method to establish its pre-eminence by sustained success. These circumstances have induced us to report three cases in which we have employed (successfully) an operative procedure, not quite like any that we have been able to discover in the literature.

We shall attempt no exhaustive consideration of the etiology and pathology of this type of fistula. Roughly there are three groups of causal factors: destructive ulceration (as in new growths), extensive inflammatory conditions, and trauma, including of course in this last category surgical trauma. To this group all of our cases belong, since each was a post-operative complication. No attempt will be made to narrate the various procedures, ranging from simple cauterization to complex operations with plastic flaps, that from time to time have been advocated for the cure of urethro-rectal fistulæ. In Tuttle's "Diseases of the Anus, Rectum and Pelvic Colon," may be found a full consideration of this phase of the subject. A few publications more or less similar to ours will be referred to, after the description of the method used in our cases, and the presentation of the case reports.

The operation may be described briefly as follows: First suprapubic drainage of the bladder is established, with the patient in dorsal posture. The patient is then shifted to the exaggerated lithotomy position. A racquet shaped incision,

PLATE XXXIV.—Presented by Dr. H. H. Young and Dr. H. B. Stone



beginning in the mid-line of the perinæum about 2 cm. anterior to the anal margin is carried backward to this margin, and then encircles it at the muco-cutaneous juncture. Through the circular part of this incision the mucosa of the rectum is dissected free all around, until a cylinder of the membrane is stripped from its attachments well above the point at which the rectal orifice of the fistula opens, the fistulous tract of course being divided transversely in this process. This ascending dissection of the bowel is carried upward until sufficient mucous membrane is loosened to permit the pulling of the segment containing the fistulous orifice well out of the anus (Plate XXXIV), the orifice and a small margin of normal mucosa above it, and all that below it, lying outside the skin level and later being excised. This part of the procedure may be described as an exaggeration of the Whitehead principle in operating for hæmorrhoids.

A minor point of some practical importance consists in beginning the dissection of the mucosa at the posterior or dorsal part of the circle. Not only is it easier to find normal planes of cleavage here, where there is no scarring, but the field is less obscured by hæmorrhage than would be the case if the anterior side is first attacked, as blood then runs down over the posterior half of the anus.

Next the structures of the perineal body are divided through the straight incision in the mid-line—the handle of the racquet—so as to expose thoroughly the urethral orifice of the fistula. It should be noted here that in all three of our cases the sphincter ani muscle had been cut in the mid-line anteriorly in previous attempts at cure of the condition, so that this part of the incision actually divided nothing but scar tissue. This scar tissue is dissected away laterally sufficiently to expose the ends of the sphincter ani muscle, the levatores ani, and the lesser muscles of the perineal floor. The edges of the urethral fistulous opening are then freshened, and brought together with catgut sutures over a sound which has been previously passed through the urethra. These sutures do not

penetrate the surface of the urethral mucous membrane. The levatores, fascia, and smaller muscles are then brought together by interrupted catgut sutures across the mid-line of the perinæum in several layers, reconstructing the perineal body much as is done in gynecological operations for relaxed vaginal outlet. Finally the sphincter ani is restored by uniting its ends with a mattress suture of catgut, and the mid-line skin incision is closed with interrupted sutures (Plate XXXV, Fig. 1). The last stage in the operation consists in the excision of the protruding cuff of rectal mucosa in which the fistulous opening lies, and the union of the lower end of the rectal tube to the anal skin margin. This is done by interrupted silk sutures after four submucous-subcutaneous sutures of catgut have been placed at quadrant points to help anchor the bowel in place.

It will be seen that there are four essential principles in this procedure. The first is the protection of the repair from leakage and muscle-spasm by diverting urine from the urethra through suprapubic drainage. This has been emphasized in the publication of a previous operation for the same purpose by one of us (Young). The second principle is the complete ablation of the damaged portion of rectal wall and the reposition of perfectly sound mucosa quite to the skin edge. Should the urethral repair break down it is hardly likely that seepage could find its way into the rectum again. The third element in the operation is the closure of the urethral orifice, and the final essential is the interposition between rectum and urethra of a solidly built up perineal body, and repair of the sphincter muscles.

THE HISTORIES OF OUR THREE CASES FOLLOW:

CASE I. W. A. M., age 26 years. Family and past history not important except as herein related. Gonorrhœal infection in July, 1905, the discharge lasting about two months. Recurrent infection in summer of 1907. In spite of various treatments, the patient continued to have trouble, especially from

PLATE XXXV—Presented by Dr. H. H. Young and Dr. H. B. Stone

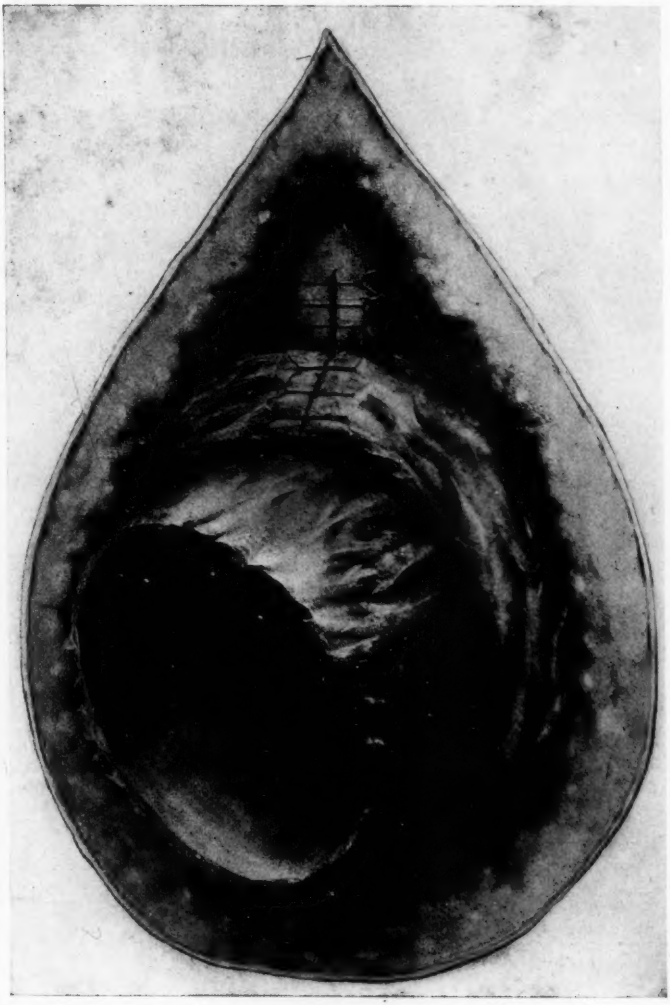


Fig. 1

Urethral fistula closed. Sphincter sutured.

Fig. 2

Closure.

prostatic involvement. An attempt at perineal prostatectomy in June, 1909, done in Nashville, Tenn., to relieve this condition, resulted in producing a urethro-rectal fistula.

The patient was operated on three successive times in the summer of 1911, in Chattanooga, Tenn. The first attempt consisted in cauterization of each of the fistulous orifices. At the second operation the fistulous tract was split through a mid-line perineal incision, the levator and sphincter ani muscles and the rectal wall being divided. As a result of this, the fistula was much enlarged, but its rectal orifice was brought down nearer the skin edge than it had been. The third trial consisted in an attempt to turn a flap over the fistula and reconstruct the sphincter ani. This was a complete failure.

Condition in January, 1913: Patient complains that when he voids practically all urine escapes through the rectal fistula, unless he closes it by pressure of finger over orifice. There is incontinence of gas and fluid stools, and these occasionally escape in part through the penis. On examination there is a depressed scar of old suprapubic incision in mid-line of lower abdomen. Perinæum shows an inverted horse-shoe shaped scar. The anus is dilated widely, has a scar in mid-line anteriorly and when patient attempts to contract sphincter it is evident that there is no muscle left except around the posterior three-fourths of the circle. Just within the rectum, in the mid-line anteriorly, one feels the rectal orifice of the fistula, about 5 mm. in diameter. Prostate small and adherent. Perinæum one mass of old scar tissue.

Operation January 27th, 1913, Drs. Young and Stone, at the Church Home and Infirmary. The operative steps as described above were executed successfully. Some difficulty was experienced both in opening the bladder for suprapubic drainage, and in dissecting the anterior wall of the rectum, because of dense scarring from previous operations. The patient left the table, however, in good condition, and with a very satisfactory repair. Convalescence was quite uneventful. The

suprapubic tube was removed after two weeks, and in six weeks this wound was firmly healed. There never was any leakage from the urethra after operation. The rectal wound healed well. The patient regained excellent control of the rectum with repair of the sphincter muscle, and when examined for discharge on March 15th, 1913, could be conservatively considered entirely cured, with urination and defecation normal.

Case II. O. T. B., age 48 years. The essentials of his history follow: As a result of post-operative catheterization, his bladder and urethra became infected with staphylococcus in 1903. Consequent to this infection, which persisted in spite of treatment, a prostatic abscess developed. This was drained through a semilunar perineal incision, at which operation the rectum was inadvertently injured, and thus a urethro-rectal fistula established. The perinæum was incised to the fistula, and the sphincter ani divided in an effort to cure the condition in 1907. This, however, was unsuccessful and another attempt was made in 1911, which likewise failed. When the patient presented himself for examination in April, 1913, the following facts were observed: About an inch and a half above the muco-cutaneous margin there is a small fistula, admitting only a fine probe, which passes from the rectum into the mid-prostatic urethra. When the patient voids, about four-fifths of the urine passes through the natural channels and about one-fifth through this fistula. The perinæum has been divided in the mid-line, and shows much scarring. The sphincter ani muscle had also been divided, but its ends have united without much retraction, so that there is fairly good control.

Operation, April 4th, 1913. The same steps were followed out, as described above. In this case the tissues of the patient were much more fibrous and difficult to dissect, but finally the operation was completed successfully, the rectal cuff drawn down well and excised with the fistula.

Postoperative history uneventful except that some œdema developed about the line of suture on the fifth day. On the

fourteenth day the patient was allowed to be out of bed and the suprapubic drainage was withdrawn. On this day the patient thought that he passed a few drops of urine through the line of suture at the muco-cutaneous margin. This day and the next, however, he was carefully watched while voiding after the operative wound had first been dried. There was absolutely no escape of fluid of any sort, so that the fistula is considered closed. The patient was discharged on the sixteenth day, at his own urgent request, although we should have kept him longer if possible.

Case III. H. M. D., age 23 years. The essential facts in the history of this case are as follows:

The patient was operated on in 1900 by the perineal route, for stone in the bladder. During the operation the rectum was wounded and the patient recovered with a recto-urethral fistula and rectal incontinence. In 1903 and 1904 operations were undertaken to cure the fistula, but without success. In 1906 he was operated on again; this time the damaged sphincter ani being repaired successfully, but the fistula was not cured. A fourth operation was done in 1908, again without success. In one of the operations, the patient does not recall just which, suprapubic drainage was employed.

Condition on April 9th, 1913. During the day, urine slowly leaks from bladder into rectum, from which it is evacuated every two to three and a half hours. In addition patient has a regular well formed bowel movement daily. At night when asleep the urine accumulates in rectum until it overflows through anus, with fecal matter, soiling bed. General health good. It is the inconvenience of his condition that chiefly concerns the patient.

Examination. Scar of old suprapubic incision in mid-line of lower abdomen. In the perinæum is an inverted V-shaped scar, well healed, and a linear scar in the median raphé also. The mid-line of the anal ring anteriorly is a mass of scar-tissue, but the sphincter functions fairly well. About 2 cm. above the muco-cutaneous margin of the rectum is an open-

ing in the anterior wall admitting a medium-sized probe, which passes then through the apex of the prostate gland and into the urethra just below the neck of the bladder. When the probe is advanced slightly it enters the bladder, and urine trickles out along the instrument.

Operation on April 10th, 1913. Same steps as above described. The dissection in this case was easier than in case No. 2, but the urethral orifice was much higher, practically involving the vesical sphincter. Repair was made without inordinate difficulty, however. Convalescence was uneventful. The suprapubic drainage was removed in fourteen days, and the patient left the hospital in twenty-one days entirely well, the recto-urethral fistula being completely cured, and the sphincter control practically normal. There is a slight tendency to escape of urine through urethra when the bladder is over-distended, and the suprapubic wound is not yet entirely healed. Otherwise the patient presents a restoration to normal.

It will be seen, in brief review, that these cases presented many difficulties. They were all of long duration, so that the fistulous tract had become thoroughly organized into dense cicatrix. They had all been subjected to repeated previous operations, rendering the whole region abnormal and extensively scarred. In each case the sphincter ani had been previously damaged, so that to the fistula itself was added disturbance of the rectal outlet. In each of these cases, belonging in a class admittedly recalcitrant to treatment, and indeed declared by the older writers to be well nigh hopeless of betterment, a most gratifying degree of success was attained. We hope that a method which has served so well in this small series of cases will be subjected to further trial. And with this hope we wish to add a perhaps needless admonition. As in all plastic work, it is essential that free mobilization be secured, so here the rectum must be freed well *above* the fistulous tract before an effort is made to bring it down to the skin edge.

Ziembicki[1] in 1889 is the first author whom we have been able to review who has at all approached this method of attack. He, too, loosened the rectum from its lower attachments. But instead of removing the fistula-bearing lower cuff of bowel, he simply sutured the openings in the urethra and rectum and then rotated the rectum somewhat to one side, so as to bring the two orifices out of line with each other. We believe our procedure possesses obvious advantages. Paul Segond,[2] in 1902, applied the principle of pulling down the rectum in attacking recto-vaginal fistulæ, and in 1903, Tedenat[3] reported having successfully operated on two cases by dilating the anus, dissecting up a cuff of rectal mucosa, closing the urethral orifice thus exposed; and then pulling the rectal mucosa down so that the rectal orifice of the fistula is brought to the anal margin. Elting[4] has adopted an analogous attack upon fistula in ano.

We were not acquainted with the paper of Tedenat until after all of our cases had been operated upon and we were considering the present publication. Unquestionably we are not the first who have realized the applicability of the "Whitehead principle" to the cure of such fistulæ as are the subject of this paper, but we desire to emphasize the importance also of the other steps involved in our procedure, the combination of all of which we believe has been the secret of success in these extremely difficult cases. It may be urged that the magnitude of the surgical undertaking is out of proportion to the extent of the lesion. We have but to call attention, in reply, to the fact that these patients had all undergone numerous previous operations without success, yet their condition was such as a result of the fistulæ, that they very gladly submitted to any proposed method of securing relief.

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DISCUSSION

DR. STONE: There is very little left to be said except to thank you for the privilege of speaking. There are one or two points about the execution of the rectal part which may be worth just a word. It is better to start the dissection of this cylinder of bowel posteriorly. In the first place, if you start it anteriorly hæmorrhage bothers when you get around behind. The attachment between the skin and mucosa is normal at the dorsal aspect, in front it is involved in scar tissue. You can strike your plane between the muscle and the mucosa better in the back.

Another point I wish to make clear is this, that it is quite essential that the bowel be freed not only up to the superior limit of the fistulous orifice, but well beyond it, because the idea of the operation is to withdraw the bowel so that the fistula may be excised and done away with entirely. So that the dissection of the bowel must continue forward into normal tissue sufficiently to allow pulling down easily. The third point is the placing of the anchor sutures to hold the bowel securely in place in its new position.

DR. EDWARD MARTIN, of Philadelphia: It seems rational. At first sight it seems unduly radical, but we have all had failures from the ordinary methods of closure, and this method may well be helpful when the simpler methods fail.

A little objection: The reason for abandoning the Whitehead excision was not incident to the fact of its difficulty, but was due to a permanent slight anæsthesia of the rectum, which interferes with a tactful discrimination between gaseous and solid rectal contents.

DR. STONE: All three of these people already had fecal incontinence when they came to us. I do not believe we did them much harm, since they now have complete control of solids and liquids.

Theses Presented by
Candidates for Admission to the Association.

THE CLINICAL DIAGNOSIS OF CONGENITAL ANOMALY IN THE KIDNEY AND URETER

By William F. Braasch, M. D., of Rochester, Minn.

In the literature of the past few years one may frequently find reports of one or two cases of congenital anomaly in the kidney and ureter. The existence of this condition was usually discovered at operation or at autopsy, and no extensive reference was made in regard to the exact clinical diagnosis. With the development of the cystoscope and the radiograph and, more recently, through the discovery of the value of these instruments in their simultaneous employment, as in pyelography,[1] we now have at our command the means to make an accurate diagnosis in practically every case of renal or ureteral anomaly.

The frequent occurrence of congenital anomaly in the kidney and ureter is not generally appreciated. A review of the records of abdominal operations at St. Mary's Hospital (Mayo Clinic) for the past five years shows that gross renal and ureteral anomalies were found in thirty-six patients. Of this number, eighteen were operated for various pathologic conditions complicating the anomaly, and seven were operated for abdominal conditions other than those of the kidney, the discovery of which was largely incidental to general abdominal exploration. In the last three years the records of those cases in St. Mary's Hospital showed that congenital anomaly was diagnosed clinically in fourteen patients; of this number, four were not operated upon for various reasons. Postmortem records of the last one hundred and seventy-one autopsies made at the clinic showed that congenital anomaly of the kidney and ureter was noted in seven cases, or over four per cent. of the total. This number includes only those gross anomalies occurring in the adult that might be regarded of surgical importance and does not include minor anomalies so frequently found in the urinary tract such as supernumerary

and aberrant renal blood vessels, fœtal lobulation, moderate degree of malposition, nor those rather frequent instances of partially deformed or moderately atrophic kidneys which may be due either to congenital or acquired etiologic factors.

The various anomalies in order of their frequency were as follows:

	NO. OF CASES
Fused or horse-shoe kidney	11
Congenital, single or asymmetric kidney	6
Atrophic kidney	5
Ectopic kidney	3
Duplication of renal pelvis and ureter	8
Ureter division	5

The pathologic condition existing in the anomalous kidney or ureter usually calls our attention, clinically, to its existence. That such kidneys are peculiarly liable to disease has been noted by various observers. The frequency with which such anomalies are found in a surgical clinic as compared with postmortem records of a general hospital would, therefore, be at least partially explained by the fact that the complicating conditions usually require surgical treatment.

Fused Kidney

The fused kidney may assume any of a great variety of forms and may be situated in various parts of the abdomen. The type of fused kidney more frequently found is the so-called horse-shoe kidney. Although its usual position is in the median abdomen at about the level of the umbilicus, it often lies more to either side of the spine. Occasionally it will be found lying diagonally, with one pole extending down into the bony pelvis. If our attention is called to the existence of a fused kidney clinically, it is usually because of some pathologic process which causes tumor or localizes pain in the median abdomen. Unfortunately, the *subjective symptoms* caused by various pathologic conditions found in the horse-

shoe kidney might easily be confused with the symptoms caused by disease in the surrounding organs. When the complication involves one-half of a symmetrically lying horse-shoe kidney the pain may be more lateral than median, as proved to be the case in three of our series. When the kidney lies asymmetrically, the median lying pole, which is usually the lower, is generally the one involved with consequent distinctly median pain or tumor. That diseased conditions of the appendix, bowel, female pelvic organs, etc., may cause median pain and tumor is well known. Rovsing[2] has recently described three cases of symmetrical lying horse-shoe kidney without visible pathologic changes, which, because of their position, evidently caused pressure on adjacent nerve trunks. He regarded the resulting pain referred across the abdomen, appearing on exercise and relieved when recumbent, as pathognomonic. Our series includes one such case but is was quite impossible to make the clinical diagnosis before operation. *Palpation* may determine a mass lying across the lower median abdomen which might be suggestive of a fused kidney but certainly would not identify it as such. Furthermore, in a large or tense abdomen it may be quite impossible accurately to determine a small median tumor such as may be caused by a median kidney. A retroperitoneal mass felt through the rectum may offer corroboratory data, particularly if the pulsation of adjacent large blood vessels can be determined. This finding, however, can be obtained with various retroperitoneal conditions other than those of the kidney.

The *radiograph shadow* of soft tissues in the abdomen is usually too inexact to permit of accurate interpretation. Occasionally, the outline of a median mass in a thin subject may be suggestive of a horse-shoe kidney. Should we find a shadow of an evident kidney stone in the lower median abdomen the possibility of a fused or ectopic kidney would be indicated. *Cystoscopic data* may be of some corroboratory value. In four of the five cases thus examined, the meati were found in their usual position in the trigone. In one, the meatus of

the ureter leading to the median lying pole was found in the median line of the trigone. Obstruction to the ureteral catheter at the level of a pelvic mass might be suggestive of some renal anomaly. However, more exact data are to be obtained through the combined use of the radiograph and the cystoscope, namely, through pyelography. The relative position of the pelves is accurately determined and any complicating dilatation or deformity of either pelvis and ureter can be clearly demonstrated. Within the past three years we were fortunate enough to secure three pyelographs of fused kidneys, all of which were complicated by a hydronephrosis in one of the poles.

On reviewing the eleven cases of fused kidney in our series, we find that nine were of the so-called horse-shoe type and two were fused kidneys, one with three separate pelves. The various conditions found complicating the anomaly were as follows:

Hydronephrosis	4
Tumor (sarcoma?)	1
Renal hæmaturia (essential)	1
Abdominal pain	1
Discovered in operating for other abdominal conditions and evidently otherwise normal	4

The sex was about equally divided, there being five males and six females. Six of the patients were below thirty years of age, and of these, five were operated upon for some complication in the kidney itself. This is of considerable interest and is in keeping with the fact that if complications (particularly certain forms of ureteral constriction) occur as the result of congenital anomaly, they will occur in the young adult, usually soon after their full development. Those anomalies occurring in patients over thirty years of age were discovered accidentally at the time of operation for some other abdominal lesion. Evidence of other congenital anomaly was found

in one patient, a female, who was found to possess a bicornate uterus.

Congenital Single Kidney

The diagnosis of the congenital absence of one kidney can be made clinically only by means of the cystoscope, and thus the condition becomes a problem largely of cystoscopic technic. Naturally, the inability to find a ureteral meatus in a markedly inflamed and contracted bladder does not necessarily indicate its congenital absence. In the hands of an experienced observer, however, the absence of any evidence of a meatus in a bladder which permits of thorough cystoscopic examination would be strong evidence of a single kidney. To further corroborate this, the Luys segregator, if carefully employed, may be of value. The injection of indigo carmine is often of aid in determining the existence of a meatus. Some difficulty may be encountered in differentiating, clinically, between acquired and congenital single kidney. When a kidney and ureter become functionless, such as occurs with a so-called autonephrectomy, the site of the former meatus will frequently remain visible and show evidence of some inflammatory change. With the congenital kidney the meatus is frequently situated in unusual positions, either in the median or extremely lateral base of the bladder. Close examination of the meatus may reveal an hypertrophy of the muscular ring about it. The peristaltic contraction will be found exaggerated. The secretion may be found unusually frequent or with unusual volume.

Of considerable interest is the pyelograph of the single kidney. The injected pelvis of the hypertrophied congenital single kidney will usually appear considerably enlarged but otherwise quite normal in outline.[3] The increase in the size of the pelvis will be commensurate with the increase in parenchyma. On the other hand, with an acquired single kidney, the several pyelographs I have made do not show any increase in the size of the pelvis.

Although a portion of the other ureter has been reported to exist by various observers,[4] in none of the three cases cystoscoped and operated upon, nor in the two cases reported in the autopsy records was any evidence found of the other ureter.

A quantitative estimate of the functional capacity of the single kidney may be of some corroborative value. The phenolsulphonephthalein test is well adapted for this purpose. A very high percentage of the chemical substance secreted such as usually occurs with two normal kidneys might be indicative of the degree of compensatory hypertrophy.

Subjective symptoms: Are of little value.

Palpation: Ability easily to feel on abdominal palpation and to determine an evident increase in its size is at best only suggestive of a single kidney. It must be remembered that one of two normal kidneys is occasionally found considerably enlarged without apparent reason. Frequently it is quite impossible to differentiate hypertrophy from a large normal kidney lying low and prominent in a thin abdomen. It may be difficult to differentiate between a small renal tumor and an hypertrophy. A tumor of the surrounding organs may closely simulate an enlarged kidney. If, however, on exploration, in the abdomen the surgeon finds that one kidney is unusually large without apparent cause, the other kidney should invariably be searched for and, if present, carefully examined for evidences of disease.

Of the six cases of congenital single kidney in our series, four were diagnosed clinically and demonstrated at operation. In one case the single kidney was tuberculous and in another the ureter was kinked so as to cause a moderate degree of mechanical obstruction. In but one patient was there any coexisting anomaly, namely, a bicornate uterus, together with absence of cervix, vagina, left tube and ovary. The kidney was found markedly hypertrophied in every instance. This might lead one to infer that where no marked hypertrophy is

noted, failure to find the other kidney may not necessarily be a congenital defect.

Atrophic Kidney

Atrophy of the kidney can be either congenital or acquired, and it may be quite impossible to differentiate their etiology on gross examination. With a marked degree of atrophy of one kidney, the other kidney is usually found hypertrophied. The discovery of hypertrophy in a kidney on abdominal exploration would necessitate examination of the other side. The clinical diagnosis of an atrophic kidney may be exceedingly difficult and when made is largely dependent on cystoscopic data.

Cystoscopic Examination: A moderate degree of atrophy could easily be overlooked in a cystoscopic examination. An evident diminution in amount of secretion on meatoscopy could easily be explained by reflex inhibition of secretion so frequently seen as the result of cystoscopic irritation. A qualitative estimate of the functional activity as evidenced by the length of time required for the kidney to secrete a chemical substance previously injected subcutaneously would be of little value so long as any normal kidney tissue is present. By means of a quantitative estimate we should be able to ascertain the functional capacity more accurately than by any other means. Unfortunately, however, with a diseased kidney on the other side the vagaries in functional estimate in the supposedly normal kidney are often so great that even a marked diminution in functional capacity does not necessarily indicate that the kidney in question is incapable of normal functional activity. Although a moderate degree of atrophy may be present without much evidence on cystoscopy, with marked atrophy, however, we have various data which should call our attention to its existence. Examination of the meatus will show an atrophy of the circular muscle usually seen about the normal meatus. The meatal contraction will be slight, the secretion will be small in amount and seen but occasionally.

The other meatus will usually show a corresponding compensatory increase.

Atrophy of the ureter is usually in keeping with the degree of renal atrophy. This is often the case in conditions of reduced renal secretory tissue in conditions other than congenital. Even a small ureteral catheter may meet with difficulty in introduction as a result of atrophic reduction in size of the ureteral lumen. The pelvis of the atrophic kidney, particularly in the congenital, may be so rudimentary that its outline in the pyelograph may be corroborative of the foregoing data.

The patient's general condition—blood pressure, ophthalmoscopic data, etc., as well as the subjective symptoms—may in themselves call our attention to the existence of renal insufficiency, in a case where the secretion from the atrophic kidney may appear normal. Atrophy of one kidney to such a degree that it would seem impossible to sustain life, and without apparent cause other than congenital, was found in five patients, in two cases the condition was found at autopsy and in one case it was demonstrated clinically. The kidneys were described as infantile in size and without other apparent evidence to cause their atrophy. The ureter was found small and atrophic in every case.

Ectopic Kidney

Anomaly in the position of the kidney may be acquired or congenital. A moderate deviation from the normal situation or a freely movable kidney is not necessarily considered a congenital anomaly. When, however, the kidney is found lying fixed in the bony pelvis or across the spine and when its blood vessels come from adjoining vessels such as the iliacs it must be regarded as a true congenital anomaly. Such a kidney is called an ectopic or pelvic kidney. Its clinical diagnosis is easily confused with various conditions in the surrounding organs. The complication which would call our attention to its existence clinically would refer the subjective symptoms to the lower abdomen and pelvis. On abdominal palpation the

ectopic kidney may readily be mistaken for an appendicial mass or a tumor of the adnexa. On rectal examination it may, in some cases, be felt as a retroperitoneal mass and when large blood vessels are felt with it the finding may be of value. However, the only accurate method of establishing the diagnosis clinically is by means of the cystoscope and the radiograph. On cystoscopy an anomalous position of the ureteral meatus may be present. The ureteral catheter can usually be introduced but a short distance. The position of the metal stylet or catheter as shown by the radiograph according to the method of Kollischer and Schmidt would localize the position of the kidney providing the stylet can be introduced into the pelvis. More graphic and complete, however, is the pyelograph, which not alone localizes the position of the kidney but also demonstrates any anatomic peculiarities in the renopelvic outline. It must be remembered that the relative position of the two pelves of an asymmetrical fused kidney, one lying in a normal position and the other lying low in the median line, might simulate the relative position of the pelves of a normal lying and ectopic kidney. This would be particularly true when the pelves of the fused kidneys are at some distance apart. Since it is the existence of some pathologic condition which calls our attention to the anatomic anomaly it is all important that we demonstrate this complication clinically. The data obtained through the cystoscope and ureteral catheter alone will aid us materially in ascertaining the identity of the complication. The pyelograph will usually be found to be of greater value, however, accurately to determine the position and extent of any pelvic distention, whether mechanical or inflammatory and to demonstrate any deformity resulting from inherent tumor. The most common complication associated with the ectopic kidney is hydronephrosis evidently as a result of its anomalous position.

Ectopic kidney was found in three patients in our series. This number does not include those numerous instances where the kidney was found lying low in the abdomen nor even those

easily movable kidneys found in the bony pelvis. It includes only such as were fixed in the bony pelvis and whose blood supply came from the adjoining vessels. As various observers[5] have noted, malformation of the various genital organs frequently occurs with such a kidney.

Anomalies of the Ureter

Duplication of the Pelvis: That the normal renal pelvis may assume any of a great variety of shapes is well known. The individual calyces may be so large and so situated that they resemble separate pelves, particularly when the calyces do not unite until well beyond the hilum. When, however, there are two distinct pelves within the hilum and each has its separate calyces and ureter, the condition must be considered as an anomalous duplication of the pelvis and becomes of practical importance. Our series includes eight cases of duplicated renal pelvis, five of which were operated upon, one was found at postmortem and two were demonstrated clinically but not operated upon. In the six cases explored evidence of a division of the two halves of the kidney was externally visible, varying from a slight depression to a distinct area of demarcation. The division is furthermore indicated in cases of true duplication by the fact that the individual poles of the kidney will have a separate blood supply. For practical purposes, therefore, the kidney might well be considered as made up of two distinct kidneys which will permit of separation if necessary. Bisection of such a kidney was performed successfully in three instances by W. J. Mayo after the clinical diagnosis had been made. The diagnosis of the pelvic duplication can be made accurately only by means of the cystoscope and radiograph combined. The finding of two separate meati on one side of the base of the bladder on cystoscopy does not necessarily indicate the existence of separate pelves, since the two ureters may unite above the bladder. Neither would two catheters introduced into separate ureters necessarily establish the existence of a duplicated pelvis since

a single pelvis may have two distinct ureters. The pyelograph offers the most accurate means to determine the relative position of the pelves and the amount of renal parenchyma separating them. Furthermore, it will determine the character and extent of any pelvic deformity which may result from some pathologic condition affecting that part of the kidney. The various pathologic conditions affecting the half of the kidney and necessitating operation were as follows: Hydronephrosis resulting from anomalous blood vessels constricting the ureter below the uretero-pelvic juncture, two cases; hydronephrosis resulting from stricture at the bladder wall, two cases; hydronephrosis and stone, one case.

Duplication of the Ureter: Morris[6] states that with duplicated pelvis the two ureters usually unite soon after leaving the hilum. In seven of the cases of duplicated pelvis in our series the two ureters were found separate along their entire course and leading into separate meati in the bladder. In one case, the two ureters were found lying in close apposition within a distinct sheath for a distance of about 6 or 8 cm. along their middle third, but without any evidence of anastomosis. The position of the two meati in the four cases cystoscoped and diagnosed was found to be variable. In two cases one meatus was found at about its normal position while the other meatus was situated posterior and more median, about 3 cm. apart. In the other two cases the distance separating them was about 1 cm. In two cases it was possible to demonstrate in the radiograph that the ureters crossed at the brim of the pelvis, which was corroborated at operation.

Division of the Ureter: The ureter may be divided at any part of its course. The most frequent point of division is at the first portion of the ureter where two more branches of the ureter leave the hilum and unite at a short distance below. Often, however, this will not be a true ureteral division but will represent the absence of a true pelvis with the union of extended infundibula instead. Division of the ureter into two branches ending in adjoining meati is occasionally met with. This division may occur along any part of its course, more

often in the lower portion. Union of the two ureters arising from normally situated kidneys and merging at about the brim of the pelvis and entering a single meatus on the right base of the bladder was found in one case of our series. This series includes five cases of division of the ureter; one case of double pelvis with two separate ureters joining a short distance below the hilum; one case of three ureters leaving a single large pelvis at various angles of the kidney and uniting at a short distance below, which was found at autopsy; two cases of division of a single ureter at the brim of the pelvis entering separate meati on the same side; one case of union of the two ureters arising from separate kidneys at the brim of the pelvis as described above and which was diagnosed clinically by means of the injected radiograph.

The clinical diagnosis of duplication of the ureter can usually be made quite easily by means of inserting metallic coated catheters into the individual ureters and then making a radiograph. This was done in three of our series of duplication. It will be found more difficult and often impossible, however, to so diagnose the divisions of the ureter. With division of a single ureter above the meatus it will be found necessary to inject fluids opaque to the X-ray in order to demonstrate the condition. This we were able to do in two instances. Furthermore, the injected radiograph will usually aid us in ascertaining the existence of any complicating lesion, such as stricture of the ureter and hydronephrosis. The following complications were found in the cases of division of the ureter: Hydronephrosis in a kidney with one ureter uniting with the ureter from the opposite kidney, one case; stone in ureter above point of lower division, one case; stricture in ureter at bladder, one case.

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RESULTS OF EXPERIMENTS ON KIDNEYS WITH ESPECIAL REFERENCE TO DECAPSULATION AND ESTABLISHMENT OF COLLATERAL CIRCULATION

By E. Hollingsworth Siter, M. D., of Philadelphia, Pa.

As there seems to be some diversity of opinion on the subject of the behavior of the kidney after decapsulation, the writer undertook some experiments on cats and dogs with the following results:

First Series

The first series was with cats.

1. January 9th, 1912. Gray cat.

Ether anæsthetic. Left kidney exposed through left abdominal incision. Capsule stripped off and kidney wrapped in omentum.

January 10th. Cat's condition was good.

January 16th. Middle abdominal incision. Kidney found firmly encapsulated in omentum. Artery tied off.

January 17th. Cat died.

Postmortem showed extensive tuberculosis of the intestinal tract. Some involvement of the lungs. Kidney normal.

2. January 10th, 1912. Black and white cat, No. 1.

Ether anæsthesia. Left abdominal incision. Left kidney exposed. Capsule stripped and kidney wrapped in omentum.

January 17th. Middle abdominal incision. Kidney firmly encapsulated in omentum. Arteries tied off.

Died January 20th.

Postmortem. Extensive tuberculosis of intestinal tract.

3. January 23d. Black and white cat, No. 2.

Ether anæsthetic. Middle abdominal incision. Left kid-

ney exposed. Capsule stripped and kidney wrapped in two layers of omentum.

February 14th. Lateral incision. Kidneys found firmly adherent to the omentum. Renal artery tied off.

February 16th. Cat's condition good.

February 23d. Cat killed by illuminating gas.

Postmortem normal. Left kidney, new capsule densely adherent. Whole organ slightly enlarged. Kidney normal.

4. January 24th, 1912. Black cat.

Median incision. Capsule stripped and kidney wrapped in two folds of omentum.

February 14th. Lateral incision. Kidneys found firmly adherent to the omentum. Renal artery tied off.

February 23d. Killed by gas.

Postmortem. New capsule firmly adherent. Kidney enlarged. Ureter patulous. Macroscopically normal.

5. January 30th, 1912. Gray cat, No. 2.

Median incision. Capsule stripped and kidney wrapped in three folds of omentum.

February 10th. Lateral incision. Omentum firmly adherent. Renal vessels tied.

February 22d. Cat killed by illuminating gas.

Postmortem. Kidney firmly encapsulated. Ureter patulous. Kidney much enlarged.

6. Black and white cat. Cat A. January 31st, 1912.

Median incision. Left kidney stripped and wrapped in two folds of omentum.

February 10th. Lateral incision. Omentum firmly adherent. Renal vessels tied.

February 28th. Killed by gas.

Postmortem. Kidney firmly encapsulated. Kidney *much* enlarged. Ureter patulous. Right kidney in this cat was cystic. Bladder was full of normal urine.

7. Gray cat. Cat B. January 31st, 1912.

Median incision. Left kidney stripped and wrapped in two folds of omentum.

February 12th. Left lateral incision. Kidney well adherent. Renal blood vessels tied.

February 22d. Cat killed by gas.

Postmortem. General condition normal. Left kidney large. Collateral circulation firmly established. Ureter patulous.

8. Gray cat. Cat C. February 1st, 1912.

Median incision. Capsule stripped and kidney wrapped in two layers of omentum.

February 12th. Left lateral incision. Renal vessels tied.

February 22d. Cat killed by gas.

Postmortem. Generally normal. Kidney well encapsulated. Ureter patulous and good collateral circulation.

Second Series

The second series was with dogs.

Dog A. Large white dog. February 5th, 1912.

Median incision. Capsule stripped and kidney wrapped in two folds of omentum.

February 12th. Left lateral incision. Kidney well encapsulated. Renal vessels tied.

February 22d. Dog killed by gas.

Postmortem. Collateral circulation well established. Kidney large. Ureter patulous.

Dog B. Small white dog. February 5th, 1912.

Median incision. Capsule stripped and kidney wrapped in two folds of omentum.

February 12th. Left lateral incision. Kidney adherent to new capsule. Vessels tied.

February 22d. Dog killed by gas.

Postmortem. Ureter patulous. Kidney large. Circulation good.

Dog C. Medium white dog. February 6th, 1912.

Median incision. Capsule stripped and kidney wrapped in two folds of omentum.

February 12th. Left lateral incision. Kidney well adherent to omentum. Vessels tied.

February 22d. Killed by gas.

Postmortem. Kidney large. Ureter patulous. Circulation established.

Dog D. Medium white dog. February 6th, 1912.

Median incision. Capsule stripped and kidney wrapped in two folds of omentum.

February 12th. Left lateral incision. Vessels tied.

February 22d. Killed by gas.

Postmortem. Large kidney. Ureter patulous. Good circulation.

Dog E. White dog. February 7th, 1912.

Median incision. Capsule stripped and kidney wrapped in two folds of omentum.

February 14th. Left lateral incision. Kidney and omentum adherent. Vessels tied.

February 22d. Killed by gas.

Postmortem. Circulation firmly established. Large kidney. Ureter patulous.

Dog F. White dog. February 7th, 1912.

Median incision. Capsule stripped and kidney wrapped in two folds of omentum.

February 14th. Left lateral incision. Vessels tied.

February 22d. Killed by gas.

Postmortem. Large well nourished kidney. Ureter patulous.

Dog G. White dog. February 8th, 1912.

Median incision. Capsule stripped and kidney wrapped in two folds of omentum.

February 14th. Left lateral incision. Vessels tied.

February 22d. Killed by gas.

Postmortem. Large kidney well encapsulated. Blood vessels well formed. Ureter patulous.

Dog H. White dog. February 8th, 1912.

Median incision. Capsule stripped and kidney wrapped in two folds of omentum.

February 14th. Left lateral incision. Kidney adherent to omentum. Vessels tied.

February 22d. Killed by gas.

Postmortem. Large kidney. Good circulation. Patulous ureter.

Dog I. Brown dog. February 9th, 1912.

Median incision. Capsule stripped and kidney wrapped in two folds of omentum.

February 14th (5 days after first operation). Left lateral incision. Kidney adherent to omentum. Vessels tied.

February 22d. Killed by gas.

Postmortem. Large kidney. More firmly adherent than on February 14th. Circulation good. Ureter patulous.

Dog J. Large brown dog. February 19th, 1912.

Median incision. Capsule stripped and kidney wrapped in two folds of omentum.

February 22d. Dog's condition good.

February 28th. Ligature on the omentum had slipped so that the kidney was not adherent to the omentum. The kidney was re-wrapped in omentum and vessels were tied off. Dog died on the 4th of March with infection of the pelvis of the kidney.

Dog K. Large Gordon setter mongrel. February 19th, 1912.

Median incision. Capsule stripped and kidney wrapped in two folds of omentum.

February 22d. Dog's condition good.

March 8th. Dog was killed by gas and left kidney was injected.

Macroscopically and microscopically the new blood vessels showed extending well into the kidney.

Dog L. Large Gordon setter mongrel. February 19th, 1912.

Median incision. Capsule stripped and left kidney wrapped in two folds of omentum.

February 22d. Dog's condition was good.

February 28th. Lateral incision was made. Renal vessels tied off.

March 5th. Right nephrectomy.

March 8th. Dog killed by gas.

Postmortem. Left kidney enlarged. Bladder full of normal urine.

Dog M. Large Gordon setter mongrel. February 19th, 1912.

Median incision. Capsule stripped and left kidney wrapped in two folds of omentum.

February 22d. Dog's condition was good.

February 28th. Lateral incision was made, and renal arteries were tied off.

March 5th. Right nephrectomy.

March 8th. Dog killed by gas.

Postmortem. Left kidney enlarged. Normal urine in bladder.

As will be seen from the foregoing, the following facts have been established:

First—That the kidney increased in size upon decapsulation.

Second—That wrapping the decapsulated kidney in the omentum is immediately successful in forming a new capsule.

Third—That collateral circulation is established at the end of ten days.

Fourth—That collateral circulation is sufficient to allow the kidney to functionate properly when the renal blood vessels are tied off.

Fifth—That the kidney remains much enlarged when the capsule is removed.

Sixth—That forming a new capsule from the omentum prevents adhesions between the kidney and surrounding soft parts and increases blood supply.

The literature is interesting and varied.

Alessandri in 1900 found that when the renal vein was ligated the kidney still maintained its function but somewhat lessened.

When the renal artery was tied there was such diminution in function that the animal could not live. When artery and vein were both tied there was a slow necrosis and reparation of the parenchyma by connective tissue.

Bobroff of Moscow found that when the vessels are ligated the organ does not necrose but function was impaired.

Cohn of Breslau found that when he tied the artery in rabbits and dogs the spermatic and supra-renal arteries supplied the organ.

Talma tied the renal artery with the result that connective tissue developed and this was followed by atrophy.

Maron reported necrosis after occlusion of one branch of renal artery in a rabbit.

Buchwald and Lettus found that while there is no inflammatory process when the vessels are tied that the organ fully atrophies.

Litten ligated vein and found a compensatory circulation established. When both vessels are tied there is atrophy of kidneys.

Giani ligated renal artery in dogs. Operation was followed by albuminuria and hæmaturia. He concludes that the

operation leads to grave circulatory disturbances; to degeneration and necrosis.

Ehrhardt experimented on six cats and after decapsulating the kidney could not demonstrate any noteworthy anastomosis between the kidney blood vessels and the connective tissue.

Auzillotti found that when the kidney had previously been decapsulated the amount of necrosis determined by the ligature of the artery was less. He writes that the compensatory circulation provoked by decapsulation does not seem to alleviate disturbances caused by ligature.

Parlavecchio decapsulated kidneys and invested them with omentum and concluded that the lesions of the kidneys were less grave and reparation more prompt and efficient.

Porcile tied a branch of the renal artery after decapsulation and after investment with omentum. Kidneys treated thus reacted more promptly to regenerative changes.

Claude saw adhesions of the decapsulated kidney to the omentum in which the newly formed blood vessels communicated with the small vessels of the parenchyma.

Muller experimented on six dogs with decapsulation and investment with omentum. He killed the dogs in fourteen days and after injecting blood vessels demonstrated them with the X-ray.

The adhesions of the omentum and the new blood vessel supply were well marked.

In three cases of nephritis in human beings the foregoing procedure diminished the albumen and improved the general condition.

Martini arrived at the conclusion with reference to experimental decapsulation in dogs that the new capsule is formed chiefly by the growth of connective tissue and is not of uniform thickness but is everywhere thicker than the normal when the kidney is surrounded by omentum. No evidence of shrinking is seen in the new capsule and much vascularization

is well conserved. By injecting after death the new blood vessels are seen to extend well into the substance of the kidney.

The new collateral blood supply is much richer than the original and the new capsule more vascular. A dog can live after established circulation following decapsulation even though the other kidney be extirpated and the vein of the remaining kidney be ligated.

Jungan reports tying both vessels in two dogs. This was followed in twenty-four hours by necrosis of all epithelium. He came to the following conclusions. No restitution of kidney after ligature. Process of regeneration missing owing to initial destruction of tissue. Kidney finally undergoes fibrocalcification.

Ignatowsky concludes that the kidney whose artery or vein is tied degenerates and atrophies.

Taddi decapsulated the kidney and invested it with omentum with the following results. New fibrous capsule poor in vessels and thicker than the former was found and upon tying the renal artery or vein thirty-seven to forty days after decapsulation five of his eight dogs died spontaneously. No compensatory circulation was noted after tying the artery. He states that the damage to the kidney by the whole procedure is irreparable and that the compensatory circulation is no greater than when the omentum is not used to surround the kidney.

Florshen did a nephrectomy on cats and implanted the peripheral vein of the omentum in the wound in the kidney and covered both kidneys with omentum. Out of nine cats operated on eight died in from six hours to five days. In the remaining cat the arteries were tied fourteen days after the implantation. Cat died in eight hours. The author concludes that while an arterial anastomosis between the omentum and kidney does occur it does not compensate for the blood supply via the renal artery.

Liek contends that the idea of surrounding the kidney with

omentum originated with Gelpke years ago and was tried by Tuffier in 1890.

Baker in 1904 proposed decapsulation with investment by omentum. Gelpke then operated on three nephritics in this manner with a betterment of their condition. Baker operated on one nephritic who died.

Girgaloff experimented on cats. Two to eight weeks after decapsulation and investment with omentum, animals were killed and aortas were injected. The injected material penetrated well within the vessels of the kidneys.

MacNider concludes as a result of occlusion of one branch of the renal artery that ligature of the posterior branch of the renal artery leads to a necrosis of the greater portion of the cortex and that an imperfect anastomosis of the two vascular zones of the kidney is possible.

Katzenstein imbedded one of the kidneys of a dog in the abdominal muscles and reduced the circulation in the renal artery. In a later experiment the renal arteries were tied. The collateral circulation was well demonstrated by injection.

Kawashima in experiments where renal arteries were tied and kidneys imbedded in abdominal muscles found kidney function normal.

Cholzow treated a number of cases of nephritis by decapsulation and investment in omentum with good results.

CLINICAL OBSERVATIONS UPON THE MECHANISM OF BLADDER CLOSURE

By Alexander A. Uhle, M. D., of Philadelphia, Pa.

THE mechanism of urination has for many years been a subject of discussion by anatomists and physiologists, the chief point of contention has been the parts played by the internal vesical sphincter and the compressor urethræ muscle in retaining urine in the bladder. Some regard the internal vesical sphincter as the muscle which closes the bladder, others, chiefly Finger, consider the compressor urethræ muscle as the essential muscle.

The anatomy of the bladder and urethra are discussed in the earliest anatomical writings. Galen first described the bladder, and regarded it as a membranous structure consisting of longitudinal, circular and transverse fibres, having around its neck a sphincter to prevent the constant escape of urine. From the time of Galen to the work of the English anatomist, Thomas Vicary, there was very little progress in anatomical science. He does not mention the three sets of fibres described by Galen, but speaks of a sphincter. Vasalius described the minute structure of the bladder wall and believed it to be membranous in character. Fallopius was the first to regard the fibres of the bladder wall as of muscular nature and even considered them under the control of the will. Spiegel called the longitudinal fibres "detrusor urinæ" and Cheseldon considered the entire musculature as a detrusor. Ellis also concluded that one strata of the bladder musculature could not contract alone. The internal sphincter was first described by Vasalius, and Sir Charles Bell gave it the name Sphincter Vesicæ Internus.

Dr. Joseph Griffiths, from whose writings these brief historical facts have been obtained, after a minute dissection of many bladders, claimed that he could find no evidence of muscular fibres at the vesical orifice to which the name sphincter

might be applied or which could act as a sphincter. The same opinion was entertained by Guthrie.

The muscular wall of the bladder is composed of an outer longitudinal and inner circular coat of fibres of the smooth non-striated variety. The vesical trigone which embryologically considered is a part of the urethra derives its musculature chiefly from the circular fibres. In addition it receives fibres from the muscular coat of the ureters, some of which are bow formed, crossing and anastomosing with the fibres from the opposite ureter, and others which converge toward the vesical outlet. The inner longitudinal coat of the urethra is continued back over the trigone, the fibres intimately interlacing with the circular coat. This arrangement accounts for the rigidity possessed by this portion of the bladder. The musculature of the male urethra consists of intrinsic and extrinsic bundles of muscle fibres. The former, of the smooth variety, are directly incorporated in the urethral wall and consist of an inner longitudinal and outer circular layer; the latter are of the striated variety and include all the muscles of the pelvic outlet, principally the compressor urethræ muscle. The inner longitudinal coat is thin but more widely distributed than the circular, extending from the vesical trigone to the orifices of Cowper's glands. The circular coat, outside of the longitudinal, is best developed at the vesical orifices where it forms a ring, three to four times the thickness of the longitudinal fibres, which it accompanies as far forward as the termination of the membranous urethra. (Piersol.) This internal sphincter encircling the commencement of the urethra is continuous with the circular fibres of the floor of the trigone, the musculature of the remaining portions of the bladder wall does not take part in its production. (Zuckerkandl.)

At the apex of the prostate the urethra is surrounded by bundles of striated muscle fibres called collectively the external vesical sphincter; below they are continuous with the fibres of the compressor muscle, an extension upward of which

they may be regarded; above they come in close relation with the lower fibres of the internal sphincter. As the urethra passes between the two layers of the triangular ligament it is surrounded by the stout annular bundles of the compressor urethræ muscle. These fibres are continued forward for some distance on the bulbous urethra, in front of the anterior layer of the triangular ligament. (Piersol.) According to Griffiths and Zuckerkandl the musculature of the bladder is not sharply defined from that of the urethra, all of the muscular coats being directly continuous with one another.

In considering the physiology of urination it is necessary to have an idea of the nerve supply of the various portions of the vesical musculature, as well as the reflex and cortical centers which control this apparatus, as far as they are known. The chief nerve supply of the bladder is derived from fibres of the hypogastric nerves and the nervi erigens. The former run from the bladder to the inferior mesenteric ganglion and to the cord by the way of the lumbar nerves; the latter reach the cord by the way of the hypogastric plexus, the hypogastric ganglion and the roots of the first, second and third sacral nerves. Each nerve contains motor and sensory fibres which supply the entire musculature. The first reflex center for urination exists in the inferior mesenteric ganglion. In dogs with the lower segment of the cord removed, control over the bladder and rectum is at first lost, but after a time the reflex act is reestablished owing to the influence of this center, as was demonstrated by the work of Goltz and Ewald. In the lower part of the cord in the region of the third and fourth sacral segments just below the center for erection and ejaculation, is the chief reflex center for bladder control, and it is probable that two separate centers exist, one for the detrusor, another for the sphincter, which are, however, very intimately associated.

The sensory fibres reach the brain by way of the posterior columns of the cord. The exact location of the cortical center for urination is not known, but it is probable that it exists

between the arm and leg center, and there are apparently subcortical centers in the optic thalamus, corpus striatum, pons and cerebellum. The motor fibres run in the anterior part of the internal capsule and cerebral peduncles and then by way of the lateral columns to the spinal center, crossing to the opposite side just before reaching it.

Stimulation of the hypogastric nerve causes sphincter contraction and relaxation of the detrusors, while stimulation of the erigens brings about detrusor contraction and sphincter relaxation.

While at the present time the control of the mechanism of urination is recognized to be of a rather complex nervous organization, it is interesting to note the views of the older physiologists relative to the opening of the vesical orifice. Rosenthal held that the urine was retained by the elasticity of the orifice, and that this elasticity gave way as result of the increase in the intravesical pressure. In experiments he found that there was a great variation in the pressure required to force the internal sphincter. It was uniformly higher in the male than in the female. Rehfisch found that the pressure required to open the internal sphincter was very variable and that when the pressure was high in the living animal it was high in the same animal when dead. He further found that while the pressure required to open the sphincter varied considerably, the pressure at which the sphincter again closed was fairly constant, and that the pressure required to overcome the same sphincter varied at different times. He also concluded, contrary to the conclusions of Rosenthal that the pressure required to relax the sphincter did not vary much in the male and female.

The elaborate experiments of v. Zeisel, Rehfisch, Frankl-Hochwart and Frohlich firmly established the control of the nervous system over the act of urination, and disposed of the pressure theory entirely.

When the bladder is empty the mucous membrane is approximated and the lumen may be regarded as obliterated.

The urethra is also closed throughout its entire extent. All writers agree that when the bladder is moderately distended the vesical orifice is closed by the internal sphincter, either by its muscular action or by its elasticity. The chief question which has always concerned anatomists, physiologists and clinicians, and which today does not seem to be entirely settled is the mechanism of bladder closure when the bladder is full and a desire to urinate is present. There is considerable difference in the amount of fluid which will cause a desire to urinate and the amount of fluid required to fully distend the bladder. It is well recognized clinically, in bladder irrigations, either by meatus irrigation, or through a catheter, that the desire to urinate occurs some time before the bladder is filled, and that this desire can be voluntarily suppressed up to a certain point of maximum toleration. The same is true in the normal filling of the bladder from the ureters, a desire to urinate occurring before the bladder is full, the desire being readily suppressed by the will to a point of imperative desire. When we endeavor to estimate the difference in quantity between the amount causing desire and that which is required to fully distend the bladder, we find it varies to a considerable extent, and is influenced by so many conditions even in the same individual that it is impossible to estimate it with any degree of accuracy. The fact, however, remains that a desire to urinate always precedes full distention of the bladder.

When the bladder capacity is estimated, we find that it varies within wide limits. In fifty normal males in whom no inflammatory condition of the urethra or bladder existed, the bladder was filled through a catheter with a warm non-irritating fluid under a uniform pressure of three feet. The average capacity of these bladders filled to a point of maximum toleration was 487 c.c. The maximum capacity was 800 c.c., the minimum 250 c.c. In only two was the maximum under 300 c.c. and in five the maximum was above 700 c.c. The average age of the patients was twenty-eight years, no patient being over fifty. Only one was under twenty years, and in this case,

a boy of sixteen, the maximum capacity of 800 c.c. was found.

As the bladder slowly fills, it passively distends, the vesical sphincter being tonically contracted. When a certain degree of distention is reached, sensory impulses arise from the stretched musculature which are interpreted in a desire to urinate. Coincident with a desire to urinate there is a reflex contraction of the detrusor muscles which is resisted by a compensatory increase in sphincter tone. If urination is postponed for any reason the desire subsides for a time but reappears with the same manifestations which are intensified. This same phenomenon recurs at intervals until in addition to a desire to urinate there appears a decidedly uncomfortable sensation of fullness, which usually compels urination. If this imperative desire to urinate is for any reason resisted the entire musculature of the pelvic outlet is voluntarily contracted to reinforce the contracted sphincters. It is only at this time that the extrinsic muscles of the urethra play any part in the bladder closure. Retention of urine may occur when this imperative desire is resisted to the extent that the detrusors can no longer contract as a result of over-stretching.

In infants urination is a pure reflex act, and remains so until the child has learned that he is capable of voluntary control. The same is true of animals in which because of a lack of education urination continues throughout life as a reflex act. The normal act of urination in man is started as a pure voluntary act, in response to sensory stimuli arising in the distended bladder wall. Nerve impulses cause a relaxation of the sphincters of the bladder and urethra and a contraction of the detrusors, which is augmented by an increase in abdominal pressure brought about by fixation of the diaphragm and abdominal muscles. The act is continued reflexly until the bladder is nearly empty, when the last portion is voided in interrupted spurts by voluntary contraction of the extrinsic urethral musculature. The bladder may be emptied even when it contains little urine and no desire is present, and sensory impulses are absent. The dominant action of the cortical

center is upon the maintenance of sphincter contraction as is manifested by the influence of emotions, fright, presence of other persons in the vicinity when urination is attempted. Sudden emotions and fright frequently cause the involuntary passage of a few drops of urine, due to the temporary removal of cerebral control of sphincter tone, while the presence of another person frequently prevents urination because the person is unable to concentrate sufficiently to inhibit sphincteric contraction.

Two opinions are held concerning the relative importance of the internal sphincter and the compressor urethræ muscle in retaining the urine in the bladder and the origin of urinary desire; some believe that the internal sphincter closes the bladder and the desire to urinate arises in the stretching of the bladder wall, and others believe that the compressor urethræ is the essential muscle in bladder closure and that a desire to urinate arises only in the mucous membrane of the deep urethra. The latter group is headed by Finger, who states that when the bladder is distended to a certain point the elasticity and tone of the internal sphincter is overcome, the posterior urethra becomes an integral part of the bladder, the urine entering the posterior urethra and giving rise to a desire to urinate. He supports his contention by stating that the urethral length is from 2 to 3 cm. shorter when the bladder is fully distended than when only moderately full. His findings are corroborated by Antal, Ultzmann, v. Frish and others. He quotes the experiments of Born, who injected the bladder of dead men with plaster of Paris, to the point of full distention, and showed the resulting cast to be pear shaped. Waldyer comes to the same conclusions after sectioning the fully distended bladder, hardened with ten per cent. formalin. Oppenheim and Low showed by Roentgenographic examination of the bladders of monkeys fully distended with bismuth and collargol that the bladder was pear shaped and the posterior urethra was a part of it.

Many of Finger's conclusions have not been corroborated

by other observers. Dittle, Furbringer, Dreyssel, Jadasohn, v. Zeissl, Zuckerkandl, Leedham-Green and others bring evidence to prove that the internal sphincter is of primary importance in bladder closure. Dittle and Dreyssel have not found a constant shortening of the urethral length, and Rehfisch while admitting some shortening never found it to exceed 1½ cm. Leedham-Green has added proof of considerable weight by his Roentgenographic studies of the distended bladder and plates showing a distinct line of demarcation between the distended bladder and the prostatic urethra.

In my own observations the urethral length did not vary much according to the degree of distention and for the purposes of comparison the urethral length was estimated in fifty cases, with moderate and maximum distention of the bladder. All estimations were made upon males of an average age of twenty-eight years. The average maximum distention was 487 c.c., the average minimum distention was 40 c.c. In 28 of the 50 there was no difference in the length of the urethra. In 22 there was an average length with the maximum distention of 18.52 cm. and an average length of 18.90 with minimum distention, a difference of 0.38 cm. Rehfisch pertinently calls attention to the fact that if the urethra became an integral portion of the distended bladder the urethral length should be uniformly shortened by a distance of about 4 cm. He also calls attention to the fact, that if the bladder is fully distended and a catheter passed into the prostatic urethra, thus suspending the action of the compressor urethræ muscle and other extrinsic urethral constrictors, the stream can be started and interrupted at will. I have repeatedly demonstrated this fact to be true, proving as it does, the voluntary control over the internal sphincter.

Following the work of Leedham-Green, I have made a number of Roentgenographic examinations of the fully distended bladder, using a twenty-five per cent. solution of cargentos (a colloidal silver oxide) which is non-irritating and casts a dense shadow. From the photographs which are herewith

submitted there is absolutely no evidence of the prostatic urethra becoming a portion of the fully distended bladder; a sharp line of demarcation exists between the full bladder and the empty urethra. In another series of photographs a metal catheter with an opening at the tip has been introduced into the prostatic urethra to a point 1 cm. from the vesical sphincter, thus removing the action of the external vesical sphincter and compressor urethræ muscles. In a third series of photographs taken during the act of urination, the deep urethra shows an almost equal distention throughout its course, and in one photograph the prostatic urethra appears spindle shaped, the internal sphincter presenting as a constriction.

A point which has been advanced to substantiate Finger's views is the clinical fact that in inflammatory diseases of the posterior urethra all portions of the urine are cloudy. This is not due as Finger assumes to the inclusion of the deep urethra in the bladder when it is full, but to the fact that the internal sphincter offers much less resistance to the passage of fluids introduced from the urethra into the bladder than from the bladder into the urethra. In catheter irrigation the fluid readily enters the bladder when the eye of the catheter is behind the compressor urethræ muscle. When a small quantity of a substance is introduced into the posterior urethra and allowed to remain for a short time it apparently regurgitates into the bladder as is shown by the fact that some of the substance exists in all portions of the urine. This was demonstrated by the work of Guyon, Casper and others who injected small quantities of methylene blue and solutions of sugar in the posterior urethra. It is probable also that in inflammatory diseases of the deep urethra, the vesical trigone is involved and causes pus formation within the bladder cavity itself.

That the regurgitation from the posterior urethra does not always take place is shown by massage of the prostate when the bladder is filled with potassium permanganate solution, and then the fluid voided in several portions. Usually the first

portion contains the debris removed by massage and loses its pink color, while the remaining portions are clear and pink. Occasionally, however, all portions are colorless.

In posterior urethroscopy with the urethrocystoscope, one does not see a funnel shaped posterior urethra, and when the flow of water is stopped, the posterior urethra collapses and nothing can be seen. When the flow is again started the urethra dilates and the water enters the bladder. A further clinical proof of the action of the internal sphincter is seen in the operation of perineal section, where the posterior urethra may be opened, while the bladder is fully distended, but no urine is obtained until the gorget is passed through the internal sphincter, and anyone who has introduced a finger into the bladder through the urethra, will acknowledge the tightness of the sphincter grasp.

The second of Finger's conclusions, namely, that a desire to urinate is due to the stimulation of the urine upon the mucosa of the deep urethra is based upon the truth of his first observation.

In a normal individual the desire to urinate depends upon the distention of the bladder musculature and not upon the stimulation of the posterior urethra. The deep urethra is without doubt the most sensitive portion of the vesico-urethral mucosa, having a very rich supply of terminal nerve endings. The vesical trigone is the most sensitive portion of the bladder wall, the fundus next and the lateral walls least of all. The nerve endings of the deep urethra respond normally to sexual stimulation, but are also responsive to the action of chemical, mechanical or inflammatory irritation manifested in a desire to urinate, pain in the urethra, frequent erections, pollutions and rectal irritability. These varied phenomena depend upon the intimate association of nerve fibres in the nerve itself or in the ganglionic plexuses from which they arise. It may, therefore, be concluded that while stimulation of the posterior urethra does cause a desire to urinate, normal urinary desire is not dependent upon it.

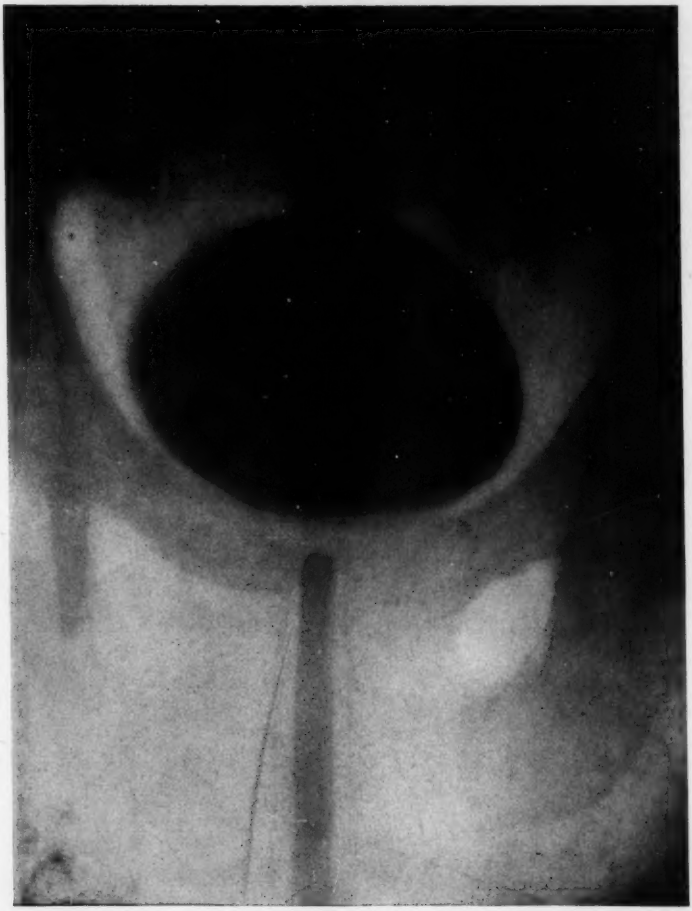
PLATE XXXVI.—Presented by DR. A. A. UHLE

Case 3. Normal bladder fully distended with 25% Cargentos showing line of demarcation between distended bladder and empty urethra.

PLATE XXXVII.—Presented by Dr. A. A. Uhle

Bladder and deep urethra during the act of urination showing the open internal sphincter and the almost equal dilatation of the prostatic urethra.

PLATE XXXVIII.—Presented by Dr. A. A. Uhle



Bladder fully distended with Cargentos and metal catheter introduced into urethra to a point 1 cm. from bladder.

In conclusion it may be stated from the evidence before us, that the internal vesical sphincter is the muscle which closes the vesical orifice and retains the urine in the bladder. The posterior urethra never becomes an integral part of the distended bladder, creating a bladder neck. The internal sphincter is under the control of the reflex center in the cord, being maintained in tonic contraction, but its activity is subject to volitional control. Urinary desire is dependent upon the distention of the bladder musculature and not upon the entrance of urine into the posterior urethra.